THE MONTHLY

JOURNAL OF SCIENCE.

AUGUST, 1879.

I. ENGLAND'S INTELLECTUAL POSITION.

THE Literary and Philosophical Society of one of the most important towns in England recently memorialised the Privy Council against the recognition of Owens College as a University. The petitioners professed to be alarmed at "the serious risks to which an undue increase in the number of degree-giving universities would expose the whole system of English education."

This plea surely insinuates that the English system of education, if not absolutely perfect, is to be regarded as superior to that of other nations, and that it could scarcely be modified except for the worse. Reflecting on the opinion thus conveyed, it seemed to us not useless to inquire what are the peculiarities of English education as compared with the systems established or aimed at amongst our neighbours and rivals, and what are the fruits of such distinctive peculiarites as manifested by England's share in the advance of culture. The foremost characteristic of English higher education—for that alone can be meant—is its monastic character. In monarchic Germany, as in republican America, a college consists merely of class-rooms, lecture-halls, libraries, laboratories, and other localities needful for research and study. The students live in lodgings in the town according to their tastes and means. The professors reside in private houses, and, so far from being forbidden to engage in any literary work without special permission, the more they create a reputation for themselves by the publication of their observations and discoveries the more honour they are considered to reflect upon the institution. With us all this is different; in a college of the normal English type the professors and students are obliged to "live in," like the hands of a modern gigantic drapery warehouse. Celibacy is the rule, by way we suppose of inducing men of high reputation to feel contented, and over the whole convent rules a Father Abbot, empowered, of his own motion, to appoint and dismiss officials irrespective of their standing, and to interfere with the details of all departments, however slight may be his qualifications to do so with benefit.

Worse still remains: the most eminent professor, instead of devoting his leisure to research, is expected to undertake the degraded and degrading task of maintaining "good order and discipline among the students." In other words, he is called upon, figuratively speaking, to assume the cocked hat and red waistcoat of Bumble! Those who are so clamorous for the maintenance of "discipline" forget that the necessity is entirely of their own creation. Enforce "residence;" shut up a number of young men together in flat violation of the order of Nature; compel the thoughtful and the studious to associate, will they nil they, with the idle, the reckless, and the profligate; give the bully a free choice of victims—and the duties of the beadle must devolve upon some one. But disperse students through the town or neighbourhood, and they will no more require any special officers for the enforcement of "good order" than would an equal number of bank clerks or young men engaged in the Civil Service.

Such, then, is the foremost peculiarity of the "system of English education"—a distinct "survival" from the days of ignorance which surely deserves exposure to something more than a mere "serious risk" of overthrow.

The second characteristic of our English colleges, as compared with their foreign rivals, is more deeply seated, and will prove much less easy to reform. It lies in the very character of the teaching given. The German professor, both by precept and example, seeks to qualify his students to add something to the existing total of human knowledge. He trains them for research, for discovery; he judges of their proficiency by the power they display of dealing with unsolved questions,—with those problems in which every branch of Science abounds. He makes them the partakers of his own investigations. The highest honours are earned *rebus gestis*.

According to our English system all this is well-nigh reversed. Men study, as Prof. Huxley well expressed it, not to "know" but to "pass." He who can make himself most fully acquainted with the works of others bears the bell, whether he is capable of conceiving an original thought and of carrying out a train of research or not. We are consequently rich in "all-round" men, who can talk with considerable fluency on every known Science, but who are neither able nor willing to extend the boundaries of any.

If we point out this sad defect in the working of our educational system we are often told, by way of excuse or justification, that English Universities are not investigational but "tuitional,"—mistuitional rather,—and that if we want seats of research we may found and endow them ourselves. But suppose we act on this kind permission, and that we attempt to secure for the institutions we have created the power of testing and recognising merit, then there are found men not ashamed to petition Government to withhold from us the power of granting degrees. We have sometimes advocated the endowment of research. Alas! we should feel but too happy if no positive hindrances were placed in its way—if there were within the four seas of Britain even one college where original work was the sole passport to distinction.

Let us not, however, condemn this wonderful "English system of education" on mere theoretical grounds, but let us examine its practical working. Are we holding our own in comparison with rival nations? Are we giving or mainly receiving light? The answer is not hard to find. Look, for instance, at chemistry. According to a summary compiled by Prof. Frankland, of 1273 memoirs embodying the results of original research, published in 1866, the United Kingdom contributed only 127, or about one-tenth; Germany producing 777, or more than half of the grand total. Worse still remains: of the papers with which Britain is here credited no inconsiderable portion is due to Germans resident in this country. We have no reason to believe that in the dozen years that have sped since this return was made the relative position of Great Britain has much improved.

But let us turn to another sphere in which we have far greater opportunities than any other nation—perhaps than all other nations combined. We refer to the exploration—geological, zoological, and botanical—of the less-known regions of the globe. It is self-evident that, with our vast colonial Empire and our ubiquitous commerce, such countries ought to be first and foremost examined by Englishmen,—that their description should be given through English publications,—and that their productions should be displayed in our museums and botanical gardens. Have we, then, even in this department, such a vast superiority as might reasonably be expected? Without the slightest wish to overlook the splendid services rendered to Science by Darwin, Wallace, Bates, and Belt, we fear we cannot reply in the affirmative. Let us take the case of New Guinea, an island of whose magnificent fauna Mr. Wallace gave us, sixteen years ago, so tempting a vision. Let us consider that it is merely separated by an arm of the sea from important thriving and energetic provinces of the British Empire, and we should naturally expect that English speaking travellers would take up and complete the task. Not so; Dr. Maclay, the Russian, and Prof. D'Albertus, the Italian, have stepped in before us. Turn even to the Fiji Islands; we have annexed them, but their thorough scientific examination has been allowed to fall into the hands of foreigners, who make better use of their scanty facilities than we do of our incomparable opportunities. In Africa the case is but too similar. Travellers from Germany,—we need only mention Dr. Schweinfurth,—from Belgium, France, Italy, Portugal, are at work in all directions, and are gathering rich spoils of discovery. We are, meantime, piously hoping to do a large business in the interior when the Zulus are disposed of. Let us beware lest we are merely conquering a market for others.

There are yet other tests to which our educational system can be submitted. Do our colleges attract students from foreign countries? With the exception, mainly, of a few Japanese our seats of learning are not frequented by strangers. Numbers of American young men go abroad to complete their studies; but they repair not to England, but to Germany. The same rule holds good with various other nations. What they require is not to be found amongst us.

Again, it may be asked whether we send out professors of the sciences to foreign nations, civilised or semi-barbarous? Are the universities, the libraries, the museums of the world to any marked extent in the hands of Englishmen? He who cannot at once answer this question with a decided negative must have spent his days in dream-land. We believe that over the whole European continent, as well as in the United States, there is not a single professorial chair occupied by an Englishman. Such posts, if not filled by natives of their respective countries, seem to fall, as a matter of course, to Germans. Science in Russia, for instance, has undergone a development which thirty years ago would have been pronounced simply impossible. But it is purely of German creation. Germans have trained and fostered speculative research in the Universities of Kazan and Perm, just as they have guided applied science in the print-works of Moscow and the foundries of Tula. So successfully has this been effected that Kazan and Perm contribute more original investigations than any British University, and that at the late Paris Exhibition Moscow outstripped Manchester and Glasgow in the purity and brightness of its alizarin-red grounds.

Turning from Russia to a country of far older civilisation, where intellectual pursuits of all kinds have undergone a striking revival, we find professorships at Turin and Rome held by distinguished Germans. In the United States, though there exists a great and increasing body of scientific men of American origin, Germany is playing her part of general instruction. Even in the quasi-civilised States of South America the same facts are to be recognised. Whatever scientific activity exists is due to Germans, and is placed under their guidance.

We see thus that over a very great part of the civilised world there is a double movement in progress; students are flocking from all ends of the earth to German seats of learning, and professors are going forth to all ends of the earth as apostles of culture. On the contrary, England is the focus of no such centrifugal and centripetal movement. As a natural consequence German literature, German ideas, German habits of thought are spreading everywhere. Nor is this, as might perhaps seem at first sight, a matter of barren honour. The German professor—settled, say, in South America or in Japan—naturally uses his influence on behalf of the German manufacturer and the German merchant. If a new branch of industry is to be introduced German engineers, or chemists, and German workmen are sent for, as is now the case with a woollen manufactory in China, which is being established on European principles. Nay, it may even be that our political weight is suffering from what foreigners cannot but regard as our inferiority and ignorance.

Such, then, is the state of affairs outside the boundaries of the British Empire. How is it within? To a very great extent, both in the home kingdoms and the colonies, we find ourselves compelled to import that intellectual eminence which we refuse to cultivate in our midst. Foreigners occupy professorial chairs in our colleges; they fill the posts of botanists and geologists to our colonial governments; they hold high positions in the respective staffs of the British Museum, of the Geological Survey of India, and of our exploring expeditions. If we pass to the regions of Applied Science we find aliens in increasing numbers managing our most important manufacturing establishments. In the year 1858 there was one foreign chemist employed in the great alkali district of south-western Lancashire. How many are there now? Nay, Dr. Reimann does not scruple to boast, in the "Faerber-Zeitung," that English manufacturers owe whatever eminence they may claim not to Englishmen, but to Germans. Making all due allowance for exaggeration, there is too much reason to own that we as a nation are sinking into the position of mere "hewers of wood and drawers of water," whilst every function requiring disciplined intelligence—save and except the miserable task of speech-making—is passing into the hands of strangers.

Now we submit that it is not in virtue of any inbred deficiency if the countrymen of Newton, of Faraday, and of a few living biologists and physicists, are outstripped in the pursuits of Science by any nation upon earth. If we fall short, as the picture we have just hastily sketched so plainly shows, it is due to that deplorable "English system of education" to which we cling with an attachment so fanatical. Are we still to go on passing examinations whilst other nations are effecting organic syntheses? Are we to accept our senior wranglers and double first-men as an equivalent for their discoverers and inventors? If so, all other reforms and "movements" notwithstanding, our abdication of the rank we once held is sealed and signed.

II. PARADOXICAL PHENOMENA IN ICE-CAVES.*

By N. M. Lowe.

In the "Scientific American" for March 29th last there appeared a letter from Mansfield, Ohio, inquiring as to the cause of the phenomena in an ice cave which is to be found in Decorah, Iowa, and for which there appears to have been as yet no cause assigned. A description of this cave is given in the same letter, of which description, so nearly as is possible, the accompanying illustration is a fair representation, as regards the main features of the case.

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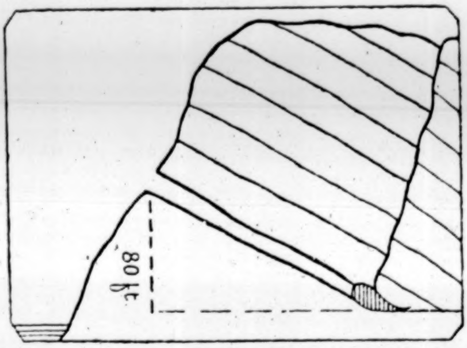
* Read before the Boston Scientific Society, April 9, 1879.



There may be a few differences as regards the details of the cave, but so nearly as can be judged from the written description the drawing presents the elements necessary to the peculiarities of the cave. In the figure the cave will be seen represented as at the bottom of an inclined passage, the inclination being that noted in the description, and the dimensions and other particulars being as nearly as possible to the proper scale. The crevice mentioned in the description may be imagined as a fault, which extends from the top of the cave to the top of the bluff, through which crevice mingled air and water finds its way to the cave.

In regard to the mingling of air with a stream of descending water, a quotation from the pamphlet of Mr. Frizzel, on the subject of the compression of air by such streams, would not be entirely out of order. On this subject he says—"It is a matter of common observation that bubbles of air rise in still water with a very moderate velocity. The velocity depends somewhat on the size of the bubbles. Bubbles, such as issue from an orifice one-eighth or one-tenth of an inch in diameter, rise from a depth of 50 feet in about fifty seconds, moving rather less than 1 foot per second near the bottom, and rather more than that near the surface. It is plain that a bubble of air drawn into water that has a downward motion of more than 1 foot per second will be carried down and subjected, in its descent, to a continually increasing pressure."

Considering, then, the description and the facts above quoted, it would not be unfair to assume that there would be a possible compression of air contained in the water, on its liberation in the cave, of about 80 lbs. to the square inch.

This assumption is supported by the fact that, from the description, the mouth of the cave would be at least 80 feet above the level of the river, and it may be inferred that as no special mention is made of the position of the entrance, save that it is in the side of a bluff, the hill may be considered as extending above the mouth of the cave to at least the distance of the latter from the river.

The phenomenon, then, of ice being found there in the summer can be referred, I think, to the theory of the liberation of compressed air brought down from a considerable height by a stream of water falling or flowing through a natural conduit or fissure in the rock, embodying the principle of the ancient and well-known *tromp* used in the Catiline forge, and still in use in Corsica, Sardinia, Savoy, and many other places.

It is only necessary to imagine such imperfection in the conduit or fissure at the initial point, which is supposed to be on the top of the bluff, or far up the mountain's side, as would admit air to come in contact with the water after it had attained a velocity of more than 1 foot a second. When the air has reached the bottom, and is liberated in the cave, it will be from a pressure equal to the height of the column of water, and it will have lost by *convection*, in the mass through which the conduit passes, the heat *due to its compression ;* and on being liberated it will immediately absorb, from the air and the water in the cave, the heat which it has lost in its downward passage.

"The most remarkable fact," that the cave freezes only in summer, and as the cold of actual winter comes on the ice in the cave gradually melts and disappears, is caused, I will venture to state as an opinion, by the gradual freezing of the surface at the top of the bluff, or the source of the air, to a considerable depth, thus sealing up the aperture through which the air entered the conduit.

Sir Roderick Murchison described a similar ice cave at Lletski, Russia, but gave no explanation as to the phenomena.

Ice wells are to be found at the foot of Mount Mansfield, in Vermont, and are really incipient caves, without depth enough to be clear of ice in winter, from the fact that the external winter temperature reaches the bottom or source of the summer ice.—*Science Observer.*

III. PAIN AND THE WEATHER.

IN his Paper on the "Relation of Neuralgic Pain to Storms and the Earth's Magnetism," read before the National Academy of Sciences, Prof. S. Weir Mitchell reported the following observations :—

Capt. Catlin, U.S. Army, lost a leg during the war, and since that time has suffered from traumatic neuralgia, sometimes in the heel, but more frequently in the toes, of the foot. He has carefully noted the effects produced on himself by changes of the weather. Dr. Mitchell's own studies in this case, as he says, "would never have proved successful had it not been for the unusual ability, interest in the task, and perseverance of the accomplished gentleman who has obliged me by making his own torments useful in the solution of the question of how far weather effects the production of certain kinds of pain." The hourly observations cover a period of five years. For the first quarters of these five years there were 2471 hours of pain; for the second quarters, 2102 hours; for the third quarters, 2056 hours; and for the last quarters, 2221 hours. The best yield of pain is in January, February, and March, and the poorest in the third quarters—July, August, and September. During these five years, while the sun was south of the equator, there were 4692 hours of pain, against 4158 hours while it was north of the equator; and the greatest amount of pain was in the quarters beginning with the winter solstice, and the least was in those beginning with the summer solstice. The average duration of the attacks for the first quarters was 22 hours, and for the third quarters only 17·9 hours.

By taking the four years ending January 1, 1879, it is found that of the 537 storms charted by the Signal Bureau, 298 belong to the two winter quarters, against 239 for the summer quarters. Hence we have the ratio of the number of storms of the winter quarters and summer quarters corresponding to the ratio of the amounts of neuralgia for these respective periods, and the ratio of average duration of each attack for the same time corresponds closely with the ratio of the respective total amounts of neuralgia for the same periods. The average distance of the storm centre at the beginning of the neuralgia attacks was 680 miles. Storms coming from the Pacific Coast are felt farthest off, "very soon after, or as they are crossing the Rocky Mountains," while storms along the Atlantic Coast are associated with milder forms of neuralgia, and are not felt until the storm centre is nearer. Rain is not essential in the production of neuralgia.

It was found that the severest neuralgic attacks of the year were those accompanying the first snows of November and December. One of the most interesting and valuable results of this series of observations is thus stated:—"Every storm, as it sweeps across the continent, consists of a vast rain area, at the centre of which is a moving space of greatest barometric depression, known as the storm centre, along which the storm moves like a bead on a thread. The rain usually precedes this by 550 to 600 miles, but before and around the rain lies a belt which may be called the neuralgic margin of the storm, and which precedes the rain about 150 miles. This fact is very deceptive, because the sufferer may be on the far edge of the storm basin of barometric depression, and see nothing of the rain, yet have pain due to the storm.—*Kansas City Review of Science and Industry.*

IV. A METHOD OF PREVENTING THE TOO RAPID COMBUSTION OF THE CARBONS IN THE ELECTRIC LAMP.

By H. W. Wiley.

In using the electric light for projections two chief points are to be considered, viz., 1st, brilliancy of illumination, and 2nd, steadiness of the light. When the source of electricity is sufficient the first of these ends is easily obtained. The second, however, is not so easy of accomplishment. The chief difficulty in the way of securing steadiness is found in the carbons themselves. Some carbons, and I find these to be the most common, burn away so rapidly that, where no mechanism is present to produce alternating currents, the electric arc is constantly passing out of the focus. Often, too, I have found that when the current is quite strong with the softer carbons, the arc would extend itself momentarily between points as far as a centimetre from the end of the carbons. At other times it would revolve about the electrodes something like a spiral flame in a pyrotechnic display. This leaping and dancing of the arc is, of course, fatal to its employment for projection.

In order, if possible to remedy these defects in a lantern which I have in almost daily use, I made the following experiments:—I first took the specific gravity of three specimens of carbon, obtained from different dealers, one in France and two in America. The specific gravity of the French carbon was 1·85; of No. 1, American, 1·53; of No. 2, American, 1·55. The French carbon is hard, of a grayish black colour. The American carbon is soft, easily broken up, and has no sign of a metallic lustre. The light from the French carbon is quite steady, and displays very little of that tendency to flicker so troublesome in the American varieties.

A positive French carbon, which had been used for several hours, until consumed nearly to the lamp, burned away at the point, but otherwise retained its original shape. This carbon was used without any previous preparation.

A soft carbon, however, of the same size as the preceding, became red-hot to a distance of 4 to 6 centimetres from the end, and rapidly wasted away; after being in use for half an hour it was reduced to a slender, tapering form.

I first tried the plan so well known in France, but so seldom tried here, of coating the carbons with a film of copper. The precipitation of the copper should take place slowly, and with a current so regulated in quantity and intensity as to produce no spongy deposits. When the soft carbons were thus prepared they worked beautifully for a short time. The light was brilliant and steady, while any green tint imparted to it by the volatilised copper produced no effect whatever prejudicial to the purpose in view. But as the carbons, little by little, became heated, the copper film oxidised, and after half an hour the carbon was again reduced to the slender form above described.

I next tried the expedient of setting a copper wire, 0·4 m.m. in diameter, into the centre of the carbons. With a thin saw I cut a longitudinal groove to the centre of the carbon, and after inserting the wire fixed it in place by filling the groove with plaster. The upper end of the wire was left projecting so that it could be brought into actual contact with the clamp. I hoped from this contrivance to hold the origin of the arc steadily at the end of the carbon, and at the same time, by increasing the conducting power, to prevent the heating and consequent rapid consumption of the electrode. In placing the carbons in the lamp the grooved sides were turned from the lens. This device proved very successful in securing a steady light, but the carbons were heated to their points of insertion in the holders, and wasted rapidly away. The point, it is true, remained blunt, but the stem of the carbon burned away so rapidly that the experiment must be regarded as unsuccessful.

It was evident from my first experiments with copper-plated carbons, that, if any way could be devised of protecting the copper from oxidation, the copper would prevent the carbon from heating by increasing its conductivity and diminishing the resistance. I accordingly covered the carbons, after copper-plating, with a film of plaster of Paris, about 1 millimetre in thickness. After this had set, the edge of the carbon, which was to be turned towards the condenser, was carefully denuded of its plaster covering, which was also cut away until quite thin on the adjacent surfaces. These precautions were taken so that the plaster might not interfere with the radiation of light in the direction of the condenser. Before use the plaster must be thoroughly and slowly dried. The copper surface at the end of the carbon being uncovered, it is fastened in the holder in the usual way. The carbons prepared in the way described left nothing to be desired. The light was steady, and the carbons burned slowly away. The film of plaster melted gradually as the point was consumed, and thus never interfered with the illumination. The points of both positive and negative carbons remained blunt, and there was no wasting away of the stem. A carbon prepared in this way will last at least ten times as long as one used in the ordinary way. But the chief advantage is found in the comparative steadiness of the light thus secured.

Carbons of the above description work best when well plated. The following numbers give what I regard as a minimum amount of copper to secure satisfactory results. In all the experiments I have tried the carbon has been of the soft American variety, with an average specific gravity of 1·55.

Length of carbon	17·5 c.m.
Each side	1 ,,
Number $\overline{\text{c.m.}}^2$ of surface, including ends	72 $\overline{\text{c.m.}}^2$
Weight before coppering	21·1615 g.
,, after coppering	24·0410 ,,
,, of copper	2·8795 ,,
,, ,, to each $\overline{\text{c.m.}}$	0·0397 ,,

In order to dispense with the use of a reflector I arrange the carbons + above, as described in the "Journal of the Franklin Institute" for May and June, 1878.

The peculiar cup-shaped appearance of the positive carbon helps to concentrate the light on the condenser. It is understood that any lamp in which the carbons are arranged end to end can be used with electrodes prepared as above. Such a lamp can be easily substituted in a lantern made for use with oxy-hydro-lime light. I use constantly such a lamp with one of Edgerton's physical lanterns originally made for the lime light. I am inclined to think a kaolin paste would be better than plaster for coating the carbons. The electric force used in all the experiments has been furnished by the Gramme machine, described in the "Journal of the Franklin Institute" already cited.

The use of projections for illustration in lectures on Chemistry and Physics has become so general that I hope the suggestions in this Paper may prove of some benefit.—*American Journal of Science and Arts.*

V. SEED-BREEDING.

By E. Lewis Sturtevant, M.D., So. Framingham, Mass.

We sow wheat in order to reap wheat, and rye in order to reap rye, and corn in order to harvest corn; and were the wheat to turn out rye, and the corn-field to yield barley, we should suffer even a greater bewilderment than did the heroes of ancient fable when they became intimate with those enchanters and sorcerers who caused fishes to indulge in conversation and mankind to become changed into beast-like forms. For the world is so subject to law that its recognition on a large scale is part of each man's daily experience; and living amid the triumphs of modern science, even the every-day labourer is educated unconsciously within the sequences of a more and more correct philosophy, so that in general terms he recognises that as he sows he must reap, and that thorns do not bear figs, nor thistles grapes. In this aspect of the case it would seem to be unreasonable to talk about heredity in plants, because the statement of the fact in general is uncalled for, being universally known and universally recognised as known. Yet we purpose to give a few thoughts on the subject, despite the apparent clearness of the claim that seeds have a heredity inherent in their nature and structure, because we recognise that the *application* of the well-known fact of heredity in these cases has not received a proper attention from the public, and that while the fact may be well apprehended, yet too few are willing to carry reasoning based on the correct premise to a logical and practical conclusion.

We certainly have no reason to believe that there is one law for vegetable and another for animal life; rather, we have firm grounds for asserting that all life is subject to the same laws of Nature, and that apparent differences are to be ascribed but to the individual under observation, being subject to forces under a greater or less antagonism, or from the simplicity or complexity of its structure and functions which render it amenable to one law rather than to another. Thus, to illustrate our proposition, we can say that a plant and an animal are subject to the action of the great natural forces which affect life and its development, such as gravity, heat, light, &c.; yet the application of a stimulus which will produce no apparent movement in the one may excite muscular action in the other; or, to make a more mechanical suggestion, a falling stream of water may serve to move a saw which shall convert a log into boards, or shall act on a more complicated series of machinery to turn a lathe which shall convert the same log into spools, or the irregular gunstock. In either case the same moving force has acted, but the work accomplished has been modified into different results through the action of another force, the mind of man, which has intervened to produce oppositions, and through the reaction of these varied oppositions has contributed to the concrete effect of the force derived from gravity upon the shaping of the log. Thus, in Nature, we have the *life*, distinguished from mineral matter by the possession of motion, and the power of adding to itself, through the force which this motion implies, from the surrounding world, of matter suited to its own structure and function, and imparting to it of its motion. Once stop this motion, destroy this mysterious force, and the life becomes subject to other conditions, and dissolves its structure, the function being lost as well, into the matter which is incapable of acting on itself to produce this added power which we call life and organism. We, however, may say that mineral is one phase of matter which is subject to one set of laws and conditions, and that life is this same matter, with added force which renders it subject to an additional set of laws and forces, which are more or less greater or less powerful, according to the complexity of the life upon which they can act. The true view of Nature is, then, according to our view, that laws are continually in action and are universal, and that it is the province of the existent life or matter to use these laws according as the structure and function affect their relations; and that hence the mind of man, which recognises and adapts existing relations to his own benefit, by modifying through law, structure, and function, can arrange relations to other laws, and produce diversity of result.

The law of inertia, which is defined as being that condition of matter by which its existing state is retained, if at rest, rest, if in motion, the continuance of that motion until other forces in action shall produce a change, serves as well for the consideration of the problem of life. A perfect likeness between parent and offspring would presuppose the parents being from all time in a state of *inertia*,—a supposition which nullifies the proposition, as the act of having offspring would be a departure from that state. Yet when we define the science of breeding, and state that "like produces like," we recognise the fallacy of the proposition as applied with exactness to individuals, and modify it immediately by limitations, which if they serve to weaken the statement, yet serve to make it not contradictory to our experience. Rather the law of variation should be the key-word for breeding, although the proposition that "like produces like" as a mental conception is as true and as applicable as is the proposition that *inertia* is a definition of a law of Nature. Like does produce like when every condition is removed which would produce difference, which only can be done as a mental act: a body is considered as continuing in its present state when every condition involving a change is removed by a mental act. Hence the "law of likeness" is of the most importance to that breeder who desires to so modify surroundings as to restrain his animals from being improved in their progeny; and the "law of variation" is deserving of the more attention from that breeder who would desire to improve his animals in their progeny.

We might amplify this proposition to almost any extent did we deem it desirable to encumber our essay with metaphysics, but we think that the careful reader or hearer will understand us in our statement that progress comes through variation, and not through likeness; that whether we breed the vegetable or the animal, it is the laws of variation which we must study and apply in order to produce progressive results: and that the law of likeness, the "like produces like" of our books, however true as an expression which must be and is followed by numberless limitations, is but of secondary importance to the practical dabbler or expert in the art of breeding, to that much more important law which embraces the variations and fixing of structures and functions which have been obtained. The pendulum swings to the right hand and to the left with a uniform motion. Any pendulum of the same length of rod and same weight of bulb, under given conditions, vibrates through the same arc. This statement may illustrate the breeder's proposition that "like produces like." Yet let any two of us make a pendulum of equal length of rod and weight of bulb at our own homes, and we would find that practically they would not move over the same arc, because we would use rods of different character or diversity, or bulbs of different centres of gravity, or would hang them differently, or would calculate the arc traversed under temperatures which were different. It is only as we understood these causes of variation that it would be possible to produce two pendulums whose oscillations would compare. This may liken the "law of variation" which is the "application law" for breeders, as distinct from the "like produces like," which is a true, yet a "theoretical law," which does not admit of practical application without the use of the "application law" as here defined. Heretofore, the tail has wagged the dog; we do not propose to stop the wag, but to have the dog wag the tail. Unless this point be understood breeding as a science will cease to progress, and, indeed, the triumphs of the art have come from the unconscious application of these facts rather than from the course which theorists have laid down:—"Variation and likeness," not "Likeness and variation." This is the new and correct method for the study of the laws of breeding as practised. Just as cultivated vegetables have in a large degree been removed from the wild vegetation, and their different status been apprehended, must their breeding science leave wild nature, and come to a cultivated application.

These remarks must be understood to have a close and practical bearing on the breeding of seed, for a plant, as being individually confined to one locality, has a limit placed by its structure and position in respect to its environment which the animal does not have, and is subject to a different order of variation. The animal progeny comes from a distinct act of the father, and the offspring following this act have characteristics determined by this and other limited systems of parentage; but the ovules of the plant receive fertilisation in general from a large number of parentages, and the seed represents, as in animals, both maternal and paternal influences. The litter of a sow are brothers and sisters; the kernels of the corn plant are not necessarily brothers and sisters, but bear the same maternal influences and different paternal influences, and hence have a variation in their growth and seeding which is dependent on a different species of relationship than in the animal. To illustrate these effects we may mention that while in carefully bred cattle the variations in the progeny are seldom, if ever, sufficient to constitute a new variety, yet Colonel Le Conteur relates that in a field of his own wheat, which he considered at least as pure as that of any of his neighbours, Professor La Gasca, found twenty-three sorts; and he goes on to state the variations in the kernels which occupy each head, and which implied such variation in growth as to necessitate the selection by single kernels in order to perpetuate a variety. In our own cornfield, with certainly no other field cultivated with a different variety nearer than a mile, on the same ear corn-grains of different colour and structure occasionally appear, and there is always a certain percentage of ears of ten and twelve rows amongst the eight-rowed normal ears of the variety. We have in our collection ears of corn with kernels of white corn, yellow corn, and sweet corn in juxtaposition, the male element so overpowering the ovule as to give to it this diverse development, and, as we must assume, chemically unlike as well.

We may next remark how much more quickly the influence of moisture, of dryness, and of heat, avail to change the aspect of the growth and the produce of vegetable life over animal life. We do know that the character of soil has an influence on the cattle grazed thereon, but this influence is seldom of a character which admits of ready definition; on the contrary, the size and shape of the plant, and even the nature of the product, may be completely changed. Thus the hemp plant in India furnishes a resin known as churras, which is stimulant and intoxicating, but does not produce it when the plant is grown in a temperate clime. The ragweed of our fields will mature its seeds and show a perfect growth on a gravel-bank, the plant being but 2 or 3 inches tall; and the same plant in fertile soil will attain the height, accompanied by a corresponding degree of development otherwise, of as many feet.

Thus we might go on and illustrate from facts which come under the observation of every one, the extreme variability of the plant nature, a variability which is to our advantage, as rendering the plant available to man according as art is exercised by him in developing these variations according to the laws of their structure, in the line of his desires. Every plant with which we are acquainted possesses this power of variation in a marked degree, and the amount of this variation can be artificially determined for it through the processes of hybridisation and of culture as applied to the plant which furnishes the seed from which the individual is derived; and it is this fact which gives to man much power. Each seed possesses its own attributes and its own powers, and its own individuality, so that the conditions for germination and growth being uniform for all, a dozen kernels of corn planted will develop a different germinative power, a different rate of growth, and a different amount of product for each.

Thus in an experiment of ours, kernels of corn were selected of the same size and from the same ear, and were planted, on land made fertile in excess, at the same time and the same depth, and on one plot no cultivation at all, but the weeds pulled by hand; on another plot, the same conditions, but the land kept clean by the hoe. It was observed that there was a different rate of germination for each kernel in the hill, and between the kernels of the adjoining hills; there was a difference in the rate of daily growth between the plants from kernels in the same hill, and that on some day the rate of growth would be reversed as between these hills—one day one plant growing in excess of the others, and other days being the most backward, &c. When the crop was harvested, we found the following for the maximum and minimum product from hills of three kernels planted:—

	Plot 1, Unhoed.		Plot 2, Hoed.	
	Corn (in ear). Lbs.	Stover. Lbs.	Corn (in ear). Lbs.	Stover. Lbs.
Greatest yield per hill	3	5½	3½	6¾
Least yield per hill ...	¾	6¾	1¼	5¼
Average	1·8	4½	2·3	5
No. of ears, all qualities:—				
Largest number ...	9 ears		9 ears	
Least number ...	2 ,,		3 ,,	

In experiments with single hills under different treatment, in another plot, the ears varied from three to ten in number, the weight of corn from 1 lb. to 3¼ lbs. in the ear, the weight of stover from 1½ to 6¼ lbs., and the total weight of hills as harvested from 3 lbs. to 9½ lbs. harvested.

In those plants which have been subjected to culture for the longest time we find variation, as a rule, more marked than in those in a state of nature. It is a curious and valuable reflection that those plants whose origin in their present form antedates the history of civilisation are at the furthest remove from the wild condition, and have become modified to such an extent as to be unable to hold their present forms without the assistance of man. We also find that wherever the part of the plant modified into use admits of a variety of forms as connected with its uses, there such exist. There is, as a rule, but slight variations between the growths of our most ancient cereals, as attention has been paid more to the grain produced than to the plant which produced it: in the cabbage family, however, where the plant rather than the seed is used, we find variation into cauliflowers, broccoli, borecoles, Brussels sprouts, savoys, cabbage, collards, or coleworts, &c., and these varieties all reproduce themselves by seed.

The art of breeding seeds is therefore to produce and select such variations as are found desirable, and then to establish these variations so that they shall be transmissible either in their present or in an improved condition, by seed. The means of breeding is through the act of selection carried on for successive generations under well-considered conditions of environment, by which the heredity of the seed in the desired direction shall be strengthened. This heredity of the seed brings us more closely to our subject.

There are many degrees of heredity, so far as the breeder is concerned. There are some plants in which the tendency of the seedling to grow into a plant but slightly varying from the parent is very strong, and such are usually wild plants which include in their ancestry countless generations of somewhat similar environment, and a uniform natural selection in action which has selected and continuously propagated the type of plant best fitted to exist amidst the dangers and difficulties of the surroundings. With such a plant the first effort of the breeder is to produce a variation, to overcome the tenacity which leads the seed to propagate in the manner of its ancestry. This tenacity is a heredity neither stronger nor weaker than that which is to be found in plants of a more sportive nature, but is the outcome of a set of conditions which have been of a similar character for a long period. The same kind of heredity, neither necessarily stronger nor weaker, leads the cultivated plant to vary. Hence we may say that fixity or unfixity of type is no proof of heredity, and that it is but in the conditions which have availed in the past that the heredity which produces likeness is to be sought.

This tendency that exists throughout Nature for one life to produce in its offspring the characteristics of its past, as well as the modifications which have availed in its near ancestry, is the law of heredity. It is a true law, which cannot be said to be manifested by exact likeness of an offspring to its progenitor, because we have instances of alternate generation which shows this not to be so; but it is a genealogical expression which is to be interpreted that the life transmits itself in its modifications; and to know what these are, in order to use this law to our advantage, we must have the history of the preceding lives,—that is, a genealogical record. Now, in the case of a seed, we desire to act upon this knowledge of what the law of heredity as applied to breeding is, and not saying that the like seed produces a like seed, must realise that the total seed of a plant may produce some good, some bad seed,—some good plants, some poor plants,—some plants better, some worse than itself; and that it is heredity which produces these variations, and that we can through the process of selection modify the heredity of the future, so as to influence future seedings. It is this gradual gain, through the influencing the heredity of the seed, that concerns the seed-breeder. This would seem to imply that the tendency of the seed is to reproduce the plant from which it was grown. This is indeed so, because, speaking of the plant as a whole, it may be said to have in its structure a species of *inertia*,—that is, it tends to keep the form and condition it already has, except as diverted therefrom by cause. We cannot think of a change happening to a life without some cause to produce it; and in just so far, and in just that direction that causes have acted, and continue to act, must this *inertia* of the plant life be overcome, and the change which is adequate to the cause take place. So far from reasoning to prove that continuation of a form in a species does exist, we prefer to say that it must be so from the law of Nature, and challenge others to show the contrary, the burden of proof being with them. Hence, from our point of view, the variations we produce in a plant must be transmitted through the seed, unless they are nullified by some opposing or counterbalancing variation which shall disguise their effect. Let us illustrate this fact:—Prof. Buckman, experimenting with the *Vicia sativa*, or vetch, by a series of five selections, so accumulated the variations that occurred, from a plant but a few inches in height, gained plants more than 3 feet in height, and increased the weight of the seeds from half a grain in the original to 1 grain, and then to 1½ grains in weight. Mr. Hallett selected his original pedigree wheat in 1857, the ear being 4⅜ inches long, and containing 47 grains; in 1861 his finest ears were 8¾ inches long, and contained 123 grains. The second year he obtained ten ears to a stool, and the fifth year fifty-two ears to a stool. This was brought about through the selection of variations, and the continued selection, whereby the effects accumulated in the heredity of the plant. In 1848 Prof. Buckman sowed seeds of the wild parsnep and wild carrot, and, by careful selection, in 1851 the plants of the parsnep presented the stems and foliage of cultivated examples, and approached them in the character of the roots. The change effected in the carrots was not nearly so great as that observed in the parsnep, the Professor observes; but still the progress was quite sufficient to show that it is within anyone's power to renew both of these plants in a cultivated form from wild specimens. It is probable that in the Concord grape, and in our fine varieties of cultivated strawberries, we have the action of selected variation to thank for the result, and none of us can fail to have noticed how soon the varieties of any fruit are offered to the public after a break in the wild species or cultivated species has occurred. Indeed, through this power of heredity, this breaking in upon the *inertia* of the wild plant by mankind—this falling back again upon a trained heredity by art—we have accomplished these wonderful results upon the nature of plants, so that now, once cause a wild plant to sport and the way is immediately opened for the breaking up of the original species into numberless varieties, which shall add to the comfort, to the necessities, or to the gratification of mankind.

If such is our power,—if heredity in life cannot be escaped from,—and if it is the causing of variation, and the fixing of the changes induced which concerns us as agriculturists, what practical lesson can we derive therefrom? We will take up the corn plant, and show what capabilities are offered to energetic and skilful effort to improve this plant through the heredity of the seed, because few species are subject to greater or more valuable variations, and hence it is especially fitted to respond to any wise effort of ours.

Zea maize, Indian corn, or simply corn, occurs within a wide range of climate, and is modified accordingly in the growth of the plant and the structure of the grain. There is a vast range between the pop-corn, whose normal length of ear is 1½ to 2 inches, and the field corn of from 9 to 12 inches, or even 15 inches; or in the number of rows of corn on the cob, which varies nominally from eight rows to twenty-four or thirty-six rows, as the "Canada 8-rowed" and the "Virginia white gourd" illustrate, and exceptionally even more or less. We find some varieties wherein the arrangement of the kernels on the cob is uniformly 8-rowed; other varieties where the rows may be either eight, or ten, or twelve; others still uniformly 12-rowed, or 16- to 22-rowed, or from 24- to 36-rowed. Some varieties bear the crop near the ground, from the lower nodes of the stalk; others, high up, on the upper nodes; and this feature of the plant is, so far as our observation extends, a true and uniform characteristic of varieties. In shape the ears may be blunt, or pointed after a manner, at the extremities; or may be of a long oval, tapering from a swollen centre towards the butt and tip ends; or may form a true taper from butt to tip; or may be cylindrical throughout. The kernel, again, may be arranged in lines wherein there is a distinct evidence of arrangement in pairs, or without any distinction or manifest separation into pairs of rows. The shape of the kernel may be nearly globular, or oval, or elongated; it may possess a flat point, or a dented extremity, or be furnished with a sharp tooth, either straight or recurved: it may be shaped like a horse's tooth, or be flattened; be longer than broad, or broader than long; may be smooth, or wrinkled, &c. In colour the kernel may be white, pale yellow, translucent, dark yellow, orange-yellow, reddish yellow, red, violet, purple, blue, slate, black, or variegated; in texture may be hard and brittle, softer and granular, and in some varieties almost gummy. Its specific gravity varies greatly—some 8-rowed, yellow, like the "Waushakum," weighing 64 lbs. to the struck bushel; others, like the Tuscarora, weighing seldom 56 lbs. to the bushel. The kernels differ in the structure of their contents: in the pop-corns the oils being distributed nearly universally throughout the kernels; in the varieties of the Canada corn the oily appearance being external to the chit and starchy portions, and forming the periphery from the hilum as a centre; in the dents, the apex being free from this oily showing; in the true Tuscarora, no oil to be recognised, &c. This arrangement, which furnishes the basis for a practical classification of varieties, seems thus far to have been unused. In the cob we find also differences between varieties which are general for each variety—the large cob and small cob, the tapering cob, the cylindrical cob, the bulging cob, the white cob, the red cob, &c. In habit of ripening, one variety may mature in from 90 to 100 days, while another variety may require from 180 to 200 days. These variations we have mentioned are not in the nature of monstrosities, or exceptional in their nature, but are general, and peculiar to varieties. They are hence strongly inherited, and transmissible by the seed in all cases when other conditions than those which have availed in the past are not brought into interference.

Hence, if sweet-corn seed be planted, sweet-corn is harvested; if a pop-corn, then the pop-corn harvest is obtained; if a red corn, then red ears are gathered; if an 8-rowed corn, an 8-rowed crop, &c., throughout the whole list. As an undoubted fact—a fact which is the explanation of our general practice of planting the seed of the crop which we would gather—each seed has a heredity which causes it to develop the plant in the line of the past growth; and whenever, through natural or artificial agency, the character of the heredity has been determined for the seed, through any process by which like forces are accumulated and stored, we find the corresponding development in the offspring. That law of inheritance whereby we say "like produces like," meaning thereby the great law of continuance of development in the line in which forces compel, is hence so evident that as breeders of seed, or of animals, we can assume it as an axiom, and drop it from our discussion as too well known, too fully realised by the educated and trained mind, to require explanation or illustration. What is of practical concern is the defining of certain kinds of heredity, the accumulation in line of desired tendencies, knowing that the law of likeness is uniform and universal, and acting always within the lines of its application. To mark out these lines, to compel the action in the direction for our profit, is the true art for practical study, use, and endeavour.

If this position be the correct one, as we firmly believe, we may pass to the consideration of "variations," knowing full well that variations in all cases have a tendency, more or less strong, to be continued in the offspring, and that, if we can retain desirable variations for a sufficient number of generations, that these will become established as permanent.

The production of variations in a plant is easily acccomplished. Any interference with the normal condition will cause them—a change of climate; a little more or less heat or moisture; the influence of crossing with the pollen of another variety; or an interference with the growth of the plant; or abundant or scant nutrition: all these, of the more evident causes, are effectual. A small eared, 8-rowed Canada corn, removed to a more genial clime than where it has been grown, increases in height of plant and in length of ear; a little greater change, and the tendency to increase of rows of grain on the cob becomes manifest. An 8-rowed flint-corn, removed and cultivated in Ohio, in one instance, became, from seven years' use, closely allied to gourd seed, being much dented, and the number of rows on the cob had increased to twelve and twenty. In Louisiana, the continued cultivation of soft gourd seed-corn from the West produced a hard flint-corn with a larger cob, in twelve years. This change, which is too well recognised to require further illustration, is also accompanied by a change in the habit of growth of the plant, which is not confined to the shape, and structure, and composition of the seed, but also to the habits of maturity,—the seed from northern localities, the first year after removal, ripening earlier than the varieties native to the region, but shortly approximating the periods common to the locality. It is this fact which enables the extension of culture into localities whose temperature will not admit of the immediate transference from southern sources, but which can be entered through the gradual cultivation through intermediate stations. Thus the potatoes, which require five months for their development in Germany, are cultivated, according to Leopold von Buch, in Lyngen, two degrees beyond the polar circle, and attaining their full development in little less than three months. The feature to be noted in these cases is, that these variations, brought about through means at the control of man, become fixed in the variety.

The effects of temperature and moisture are of great avail towards changing the habits of the plant, yet from the nature of the case cannot be well separated and defined. We have observed a difference in the transpiration of water from different plants, a variation which is of extreme importance as leading to the selection of that variety which requires the least water for the processes of growth, for planting in drouthy localities, and *vice versâ*. Heat alone, moisture in sufficient quantity being present, tends to an elongation of the internode of the plant, while a diminution of temperature tends to shorten the nodes, and is suggestive of other changes in the character of the plant and its fruitage. As a general rule, for varieties of corn which are quite similar, elongation of the internodes means an influence on the ear; but there seems to be many exceptions, and the matter is worthy of further study.

The influence of hybridisation in corn is very peculiar, but always results in a change of character in the kernel. Thus we have before us an ear of a pale yellow field-variety which contains sweet-corn kernels, wrinkled, sweet, and of their proper shape. In this case the pollen has determined the development of the ovule of another variety so as to disguise completely the natural order of its development. We have another ear of a deep red corn, whereon the influence of the foreign pollen has been to modify the shape and the colour of the few kernels affected in such a manner that they seem intermediate in character between the two parentages, and in other kernels the influence of the pollination seems to be confined to distinct localities of the kernel. In these variations, these departures from the variety, we have the means at hand for further progress in an intermediate or diverse direction from either parent, because, as is too well known for argument, or even statement, the produce from these kernels would show effects resulting from this departure from the type of either parentage.

The influence of interference with the growth of the plant, in order to produce variation, seems not to have attracted the attention of authors, although of great interest. In some experiments of our own we have found that the obstruction to the flow of sap in the stalk, whether by ligature or by splitting the stalk and injuring the pith in the cross-section, has been in all cases followed by the elongation of the foot-stalk of the ear, and we have thus secured a branching corn-plant. This treatment increased the rate of growth of the plant in height, caused an earlier bloom, and increased the amount of produce over that of adjoining hills not thus treated. The removal of the upper nodes of the plant early in the season has caused a development of ears from the lower nodes, which in the variety experimented upon are universally barren as cultivated in the fields. When the leaves were cut from the ear-wrappings (not the leaf-stalks which form the husk, but the leaf extremities which are formed beyond the ear), the effect on the ear was manifested by irregularity of kernel development; when the leaves were reduced on the plant during growth to a large extent, the growth was little vigorous, the plant was stunted, and, although there was an appearance of earing, there were no ears developed into crop, but all were of the class called pig-ears. When the stalks of the plant were daily twisted until a snap could be heard, the earing was very abundant, far more so than in other plants, but all did not develop into crop. When the lower roots were all removed from a plant, by digging up the seed soon after vegetation had commenced, and cutting off all the roots below the seed (removing the radicle), the plant showed a character of growth different from that of normal plants, throughout the season, and tillered largely; one hill which had the flowering-stalks of the plants broken down at the period of bloom gave a better lot of ears, and a plumper kernel, than did another hill whose plants had the flowering-stalk entirely removed; but the number of plants thus experimented on were too few to offer results to afford data for a reliable conclusion.

We now have indicated, in a general way, how variations may be produced, giving data but from experience. We might add, from theoretical grounds, the planting of seed from peloric ears or tassels, from using mutilated seeds, or seed from mutilated plants, from butt kernels or tip kernels, from ears in abnormal positions on the stalk, or from kernels in irregular positions on the cob.

Had we no other means of arriving at a conclusion of the antiquity of maize as a cultivated plant, this very fact of its pliability towards changed conditions, and the manner of its present sportiveness, would be ample. It is indeed far removed from a wild state, and has become domesticated, if we may use the term in this connection. Its present form, in any given case or variety, has been derived from the accumulation of tendencies which have been impressed on its varied generations by the needs of corn-eating man. In those features which have attracted the attention of its growers it shows this variability. In those other features which have been overlooked, and which, if influenced at all by man, have been through correlations, the plant shows a degree of stability which it is difficult to overcome. For instance, the "Waushakum" corn-plant bears its ears on the fifth node from the first, and developes embryo ears at the five nodes counting from the first which sends forth roots. Through no effort of ours have we been able as yet to change its nature in this respect. We have succeeded in causing the ear to be developed on the fourth, or third, or second, or first, counting downward, but never on the sixth, the seventh, or the eighth. We have not been able, so far as we have observed, to change the plant from a nine-noded one or less, through manure or any other process we have as yet tried. This method of structure has remained constant, because there has been no effort in the past by any one to produce variation, as no variation in this line has promised advantage or been brought to the attention. Yet we have been enabled to vary the grain, the shape of the cob, and the habit of growth, the most readily in those directions in which a practical usefulness could be seen. Indeed the teleological argument is a fitting one as between the plant and man. In other varieties of corn we find a different arrangement of parts, and as strictly defined in the variety as in the case given. Thus a variety grown in Tennessee contains sixteen nodes in all, and the first ear appears on the fifth from the bottom, and on each intervening node up to and including the twelfth. Darling's early sweet corn produces its ears near the ground, as a variety characteristic, as does also the Narragansett, and some pop-corns we have grown. In the Southern white corn, as grown for fodder in New England, the ears develop high up on the stalk.

If we pass to intermediate characteristics, those which probably have been valued as a peculiarity of variety through many generations of culture, we find a fixity which is quite difficult to overcome except through successive efforts, if at all. Colour is perhaps the most prominent. Thus the red corn, occasionally cultivated here and there in New England, and which, although out of general culture, is tenaciously held on to by individuals, presents a fixity of type which overcomes in most instances the effect of hybridisation even in its colour. We know of instances where it is claimed for it that it does not receive hybridisation from other varieties of corn, because the colour continues, but a careful examination of those ears we have seen, and which have been grown among other corn, has shown an influence in the shape and quality of the kernel; and if in a few cases the colour has changed, or become modified, this fact but proves by its exceptional occurrence the fixity of the colour peculiarity. The red cob is another instance in point. We know that some growers place a value on this peculiarity, just as certain features of little real consequence have become valued in poultry by fanciers. We have known of instances where through hybridisation the colour of a kernel and the shape have become changed, while the cob has retained, apparently, its variety characteristic of a red colour. In the arrangement of the kernels we have a feature wherein there has been little effort to fix the number, as the benefit of a fixity of type here has not been generally recognised. Hence we find in this respect a great variability, and there are but few varieties wherein a good percentage of other numbered rows than the normal number do not appear. Scarcely a field of eight-rowed corn but what will show ten- or twelve-rowed ears to the searcher after them. Scarcely a twelve-rowed corn wherein eight-, or fourteen-, or sixteen-rowed specimens do not exist.

The means in the power of the seed-grower to improve his seed is now indicated, and their efficacy has been shown. It is not heredity; it is not that the seed will produce a plant and a seed like its parent plant; it is no new and novel proposition which has been untried, but, as shown by all the facts of experience and reasoning, it is in the accumulation of desired qualities so as to determine the character inherited; for, let us repeat, even if charged with tautology, that heredity is general in the poor and the good seed alike, in the desirable as well as the undesirable qualities, and that it is but the character of the qualities which are transmitted which concern us most intimately in our efforts to improve. To accumulate good qualities to be transmitted in the stead of less desirable qualities,—to gain even an advance this year, and again another the next, and so on continuously, is the secret of breeding. It is not the plant like the parent plant that is the most profitable, but the better plant than the parent, and all that is to be done is to cause the individual plant to vary for the better, and then to hold on to the gain by each year, each generation to fix this good quality and to add on to it, so that it shall become a characteristic of the variety or the breed. The art of selection, the practice of selection, the continuous adding and subtracting of qualities from our plant is the secret, as well as the plain common-sense of breeding. So long as law prevails and forces act, we have in our plant, in our seed as representative of the plant, the reproduction of those qualities which have been impressed upon it from the past, and by changing these qualities in the present we can pass them along through the intervention of the seed, to future generations, and thus, through the continuous additions and strengthenings, can form the plant which shall devote itself to the carrying out of our desires, and which shall in a measure eventually overcome even what at first thought we would call the design of Nature.

Thus, through selection, winter and spring wheat, which botanically have been considered distinct species, have been transformed the one into the other. The beet-sugar plant, since its introduction into cultivation for sugar in France, has had its percentage of sugar almost exactly doubled through the agency of most careful selection and testing of roots gathered to be used for the growing of seed. By selection during a course of years the early maturity of peas in Great Britain has been hastened from ten to twenty-one days. Among florists' plants the Canterbury bell was doubled by four generations of selection. The wild cabbage plant has been developed into at least ten distinct varieties through cultivation; the crab has been transformed into the apple; the sloe into the plum; the wild grape into the concord grape; the wild strawberry into the large and fine cultivated species, and each year brings numerous varieties thus gained before the purchasing public. The whole secret of all these triumphs being the production of or the seeking for variation, and then putting into action a rigorous selection.

How rapidly changes may take place in a plant through yearly variation is shown by the results of Metzger's growing of corn in Germany from foreign seed. In the third generation, in one case, nearly all resemblance to the original and very distinct parent form was lost, and in the sixth generation this maize perfectly resembled a European variety. In another case, with a "white-tooth corn," the tooth nearly disappeared in the second generation. In our own experience we find that various features of the corn plant resist acts of selection more strongly than do others. It has seemed to us that three generations of selection have sufficed to change the size of the cob and the shape of the cob; that it has had a strong influence in changing the character of the grain, but has not yet fixed it; and that it has had a less effect on the earing habit of the plant, and yet an effect which is very noticeable and persistent.

Let us now consider the corn plant alone, and see what features we desire to obtain, and what must be the principle of selection which would seem the most efficient to bring us success.

As a rule, the one feature of the plant that concerns the farmer the most is that of prolificacy. There is less difference betweeen the values of different qualities of corn grain, from a sale point of view, than there is between the yield of different varieties. Seventy-five bushels per acre of any variety grown is usually more valuable than forty bushels of another variety, and yet these figures represent actual differences which may prevail in the same neighbourhood. Hence how to increase the corn crop is an important question. This cannot be done by manuring alone, or by culture alone, but through the intervention of seed selection. If we plant a kernel of corn by itself, and dung it and care for it, we are sure to have an ear produced from it; and yet if this same kernel be planted in a field where it has to overcome disadvantages arising from the presence of other plants, and less of individual condition concentrated in itself, we are not as sure. In field culture we always find barren stalks in greater or less number, according to variety; we always find small ears—pig corn as we call them—no matter the amount of fertility; we always find perfectly formed and shapely ears scarce. This fact of non-productive plants can be proven by a calculation of the amount of grain which would be harvested from fields variously planted, *provided* each stalk furnished one first-class ear.

To plant an acre in hills $3\frac{1}{2} \times 3\frac{1}{2}$ feet distance, and four kernels in a hill, requires 14,224 kernels of corn. If each produced one stalk only, and one good ear shelling 7 ounces of corn,—not an impossible amount for a first-class ear,—the yield would be 111 bushels. If the acre be planted in drills, $3\frac{1}{2}$ feet apart, and hills every 28 inches, containing four kernels, the number of hills planted is 5335, the number of kernels 21,340, and the yield in the same supposition of 7 ounces would be 165 bushels. As a matter of fact it is not uncommon to harvest 3 lbs. of ears from a hill of three kernels, and 4 lbs. from a selected hill of four kernels, or 1 lb. of corn in the ear to a kernel planted. If we accept this as a maximum our yield would, on the suppositions above, be 355 bushels of ears (40 lbs.) and 533 bushels of ears per acre.

These calculations are not offered to show the crop that may be grown, but simply to illustrate the difference we find in practice between our ordinary yields and yields from the best hills of our field, in order to make evident the proposition that improvement in our seed-corn is needed, and that each farmer can find in his field the hint for the direction of this improvement. Whatever man can improve his seed so that every plant shall be the equal to the best of his planting has accomplished the difficult and scientific feat of the formation of a variety which is at present beyond aught that we have reached.

Now manure will not cause prolificacy to an equal extent in corn plants from various seed, as we have shown that under excessive manuring the variation in crop between sixteen hills under like treatment has been as 1 to 3¼ by weight of corn on ear, and as 1½ to 6¾ lbs. of stover per hill. Under ordinary manuring the difference has been nearly or quite as great. Under insufficient manuring the variations appear even greater. We desire to lay stress upon this fact, that manuring does not produce crop by itself, and that increase of manure is not necessarily followed by increase of crop. We know of a field which received thirty-five cords of manure per acre, and yet another field fertilised with six or seven bags of Stockbridge corn manure to the acre gave a larger and fairer yield of corn. On Waushakum farm, one rather poor (as we have considered it) piece of land, which has been heavily cropped by the aid of Stockbridge manures in past years, yielded 66 bushels of corn this year when manured with seven bags of Stockbridge fertiliser; while another field, considered our best land, manured with about 5½ cords of clear cow-dung and six bags of Stockbridge fertiliser, yielded 66 bushels (or exactly 131⅓, and 132 baskets of 41 lbs., respectively, per acre). Hence manure is but an element, an important one, but not sufficient in itself to furnish us large increase of crop.

Will cultivation do it? We can say also the like for our culture, that it is an important factor in the improvement of corn, and yet is not all-sufficient, being but a factor. In an experiment to determine this we took a suitable plot of ground, and manured it most excessively, so as to eliminate by the abundance of fertility the specific effect of the manure in producing differences between the yields (some forty-two cords of cow-dung per acre, besides abundant chemical fertilisation), and planting in hills 4 × 4 feet apart, three kernels to each hill, using selected corn and equivalent conditions of planting: we had three plots, each containing sixteen hills. Plot I. received no culture whatsoever, the weeds being pulled by hand. Plot II. was hoed thoroughly and frequently during the season. Plot III. was weeded by hand, as Plot I., but a knife was run vertically around each hill to the depth of 6 or 7 inches, at various times during growth. The following are the results of harvest;—

TABLE I.

	No. of hills.	Weight of corn in ear.	Weight of fodder.	Proportion of ear-corn to fodder.	No. of ears.	Length of ears.
Plot I.	16	29¼	72	1 : 2·46 lbs.	86	643¾ ins.
„ II.	16	37¼	81	1 : 2·17 „	92	752 „
„ III.	16	33¾	48¾	1 : 1·44 „	104	774 „

TABLE II.

	Total No. of ears.	No. of good ears.	No. of fair ears.	No. of poor ears.	Ears good as seed.	Merchantable ears.
Plot I.	86	38	6	42	2	44
,, II.	92	57	13	22	5	70
,, III.	104*	47	22	35	26	69

We can study this table with advantage, as there is shown an influence of cultivation upon the ear and upon the crop, which conforms to the general experience of farmers, and hence is undoubtedly a true and not an exceptional influence.

It is to the selection of the seed that we must look for the important factor, which manure and cultivation shall act upon to give the largest possible result. As a rule, seed has been selected with reference to the grain, and not with reference to the plant. We hence find many varieties of corn with grain of superior quality and ears of fair appearance, but the appearance of the ear gives us but little clue to the prolificacy of the plant. In our own experience we have had the results from seed corn from similar ears vary as 2 to 1, or as an actual result 55 bushels of grain per acre from the one, and 110 bushels from the other, under equivalent conditions of treatment. It is to the corn plant that we must look first in the improving of seed corn through selection, and we must bear in mind continuously the principles of breeding, remembering that by a law of nature the seed *must* transmit the tendencies it has itself inherited and acquired.

If there is one principle of breeding which is more fully and satisfactorily determined than another, it is that of the survival of the fittest. That animal or plant which is best fitted to overcome obstacles is the one which in the long run will succeed in establishing itself and its race. If we desire to modify individuals of either class, animals or plants, we by our interference furnish them advantages which aid them in overcoming, or prevent them from coming into conflict with the competition which they cannot endure. Thus our corn plant is protected during growth from competing for the possession of the ground with weeds; it is aided and encouraged through the furnishing of conditions suited to root-extension by means of the plough, the harrow, and the cultivator, &c. If we study the corn plant with reference to its parts, we find the same rule to apply. If we encourage an excess or produce a deficiency of leaf surface, the grain suffers from our interference. If we examine into the physiological structure of the stalk, we find that nature has provided the embryos of many ears, but that in the ordinary course of events, one ear, usually the upper one, develops, attracts to itself through its superior vitality the nutriment from the stalk, while the lower embryos are apparently unable to struggle against this prepotency of the one, and starve. We can state as facts that in a field where the average productive stalk yields but one ear, and this the upper one, its removal will cause the next lower to develop and form the crop; and thus by our interference we can cause the one to develop which we shall aid by removing its competitors in the struggle to secure the advantage.

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* Three ears of large size too much affected by smut to count in the harvest. On Plot I. considerable smut, but none to destroy the ears. On Plot II. less smut, but no ears destroyed.

What conclusion, then, can be logically derived from what we have stated?

1st. It seems to us clear that our first effort for the improvement of seed corn is to remove the changes which come through the hybridising of the corn by pollen from infertile stalks, as thus confining the heredity each year within the lines of productive parents, and thus bringing the heredity to act stronger and stronger in the way most agreeable to our profits. This is one species of selection, one influencing of variation, the selecting of prolific parents, and the causing thereby of variation in the direction desired. This has now been practised for two years with the "Waushakum thoroughbred corn," and the effects are strongly evidenced already, while the show for a still greater improvement is very promising. The inheritance or transmissal of qualities is always present in a seed, but we are securing the transmissal of good qualities, and eliminating the bad qualities—meaning good and bad in their relations to man—by this most influential and important method of selection.

2nd. The next direction for selection, as taught by these principles we have referred to, is of the ear. It is of advantage to select seed from plants which develop twin ears, but as the influence of cross-fertilisation as usually allowed by the grower, is to introduce a tendency to barrenness, this way of improving our yields of corn is slow in practice, and possesses an element of uncertainty which should be eliminated. In using seed of a strong tendency towards developing two ears to a stalk, we obtain perhaps the two ears, but the kernels on these two ears, perhaps, are fertilised by pollen from a plant which does not develop any ear at all; the seed thus grown has a divided quality; it inherits from the mother plant a tendency towards fruitfulness, and from the father plant the tendency to barrenness, and according to the prepotency of either must the result be. While there is therefore a usefulness in the taking of seed corn from a twin-eared plant, this method of selection must be secondary to the first, so long as barren stalks abound in our fields and furnish pollen.

3rd. There is another method of selection which has a relationship to the 2nd, and which has not in practice, so far as we have observed, received the attention which its theoretical importance would seem to warrant. This is the influence of the position of the ear. The upper ear of the stalk, in many of our New England field varieties certainly, and doubtless in the majority, has a prepotency which enables it to develop normally at the expense of the lower embryo ears. Under moderate or poor manuring, this ear (if any) always, so far as we have critically observed, develops, and none others; under better manuring, a second ear, and always, so far as our observation extends, the one immediately below the upper one may develop, but it is probable will not be the equal to the first: under heavy manuring, a third, or even a fourth, may develop, but the quality is apt to deteriorate as we proceed from the top. This series of facts, if facts they are, indicate that the prepotency of the ears decreases as they occupy positions nearer to the ground. In the selection of seed-corn, therefore, we should endeavour to secure the lowest ear on the stock for seed purposes, as we thus are using seed which by overcoming the difficulties of position has proved itself to have great prepotency and vigour, and as the prepotency increases as we go upward, the selection of the lowest ear gives us the advantage of, as well as selecting, a prepotency of position which shall affect the development of all the ears which grow above it, or a plant prepotency, with reference to its seed bearing qualities, as well as the one prepotency we have selected for continuance.

We thus have indicated the three guiding selections which should be the careful concern of the seed-breeder. How long it shall take to secure the fixity of these qualities by continuous selection we cannot say with certainty for any given case, but for limits we have slight reasons for supposing seven and sixteen years. We know from experience that three years only are productive of recognised benefits.

The character of the grain and its arrangements on the cob, the length of cob, &c., are minor objects for the breeder's care, as requiring less time to fix, as being most readily apprehended, and as showing results so quickly as to encourage continued efforts. These minor characters can usually be fixed by three years of selection, if any variety of ordinary culture be worked on, and if the changes desired are not outside of the fixed characters of the variety. If we shall attempt to change a field corn into a sweet corn through other selections than those influenced by hybridisation between the two, or *vice versâ*, we shall have difficulty, perhaps shall fail, most probably shall not succeed. We can always place our efforts most successfully where the plant experimented on indicates by the nature of its variation the direction for us to act. Do we wish to change an 8-rowed corn into a 12-rowed corn? We shall do it more readily with a variety that presents frequent variations from the 8-rowed form, than with another where this variation seldom occurs. Do we wish to diminish the proportion of the cob to the grain? We can do this more readily with a variety where the proportion already existing is far from uniform, than with another variety where the proportion is quite uniform. Do we wish to lenghthen our ears? We can do this the more readily with a variety which varies greatly in the number of ovaries in line on the cob, than with another which presents a more uniform number, &c.

We believe that by the proper selection of varieties to be used as a beginning to work from, that we can so far offset the influences of climate as to grow a flint corn into a dent corn, or *vice versa*; a pop-corn into a field corn; a yellow corn into a white corn; a flat corn kernel into a rounded kernel; a deep-kerneled corn into a shallow-kerneled corn; an 8-rowed corn into a 10, 12, 16, or more, rowed corn; a large cob into a small cob; a short cob into a long cob; an ordinary variety of corn into a branching variety, &c. We believe that the corn ear can be removed, through selection, from the upper node to an intermediate one; can be borne on branches either terminal or axillary; can be transferred to the tassel, &c. In a word, that under the axiomatic law of inheritance, or the transmissal of forces, the process of selection will produce these changes we have indicated.

What kind of corn should the New England farmer seek to develop? First and last, one possessing prolificacy, as being the most important quality and the most difficult to be attained. Then smallness of cob, as being a correlative with the stalk (to be used and found exceedingly valuable as a forage plant if small and thus easily cured) and as having a direct bearing on the storage of the crop. A small-cobbed corn can be binned in larger piles and earlier in the season than a coarse-cobbed corn, with less danger from mould, and is earlier to be husked and earlier to be binned, and earlier to be shelled and marketed, on account of the small cob drying out its moisture more readily and quickly. Then length of ear, as diminishing the labour of husking. Then depth of kernel and closeness of packing on the cob, a most evident economy. Then uniformity of kernel, as adapting the grain to more varied uses. Then colour, as having a relation to ease in marketing, because if one coloured corn sells more readily than another coloured corn, it is more desirable to be grown.

We would also call attention to the importance of securing adaptability to climate, and to the farm. This can be obtained by closely watching the corn of the farm, and using the evident changes produced by the locality to influence our selection. If there is a difficulty in keeping a 12-rowed variety from changing to an 8-rowed variety; that is to say, that if the 8-rowed ears are constantly appearing in the crop planted from a 12-rowed seed, then it is probable that your selection had better be towards the 8-rowed variation, rather than attempting to retain the 12-rowed.

The improvement of seed corn through systematic effort, guided by careful study of what facts we possess, has scarcely yet attracted the attention it deserves. Success, it seems to us, can be hoped for, and he who undertakes it understandingly must win some degree of success, sufficient at least to amply repay for the trouble and care, besides the satisfaction which shall attend the effort. It is for farmers to assist such an effort by demanding good seed, and by paying for good seed a price sufficient to remunerate the grower.—*From the Report of the Secretary of Conn. Board of Agriculture*, 1878.

NOTICES OF BOOKS.

Scientific Lectures. By Sir JOHN LUBBOCK, Bart. London: Macmillan and Co.

IN this volume the author gives a clear, though necessarily much condensed, view of the results of modern research on the mutual adaptation of plants and insects, and on the habits of ants—a subject which he has personally investigated with perseverance and success.

A particular interest attaches to the attempt made to explain not merely the general colouration, but even the pattern of caterpillars, by a reference to their necessity for concealment. The view taken by Dr. Weissman in his able monograph on the larvæ of the Sphingidæ, and, we believe independently, by the author, is that longitudinal lines prevail among such species as feed on grasses or other narrow-leaved plants, whilst such as browse upon broad-leaved plants exhibit diagonal bands. Thus *Smerinthus quercus*, *S. tiliæ*, *S. populi, and Sphinx convolvuli*—feeding respectively on the oak, the lime, the poplar, and the convolvulus—are all characterised by diagonal lines on their sides. On the other hand, *Anceryx pinastri*, which eats the narrow needle-like leaves of fir trees, has merely longitudinal lines. The chief difficulty in the way is that the larvæ of not a few species have more than one food-plant, and may be found both on broad leaved and narrow-leaved vegetables. Thus *Chærocampa celerio*, *C. elpenor*, and *C. porcellus* feed upon comparatively narrow-leaved plants, such as different species of *Galium* and *Epilobium*. Certain entomologists, however,—such as Meigen,—declare that they feed also upon the vine, one of the broadest-leaved of European trees. We have ourselves taken *C. celerio* upon the vine, and can testify that *C. elpenor* and *C. porcellus* in captivity feed quite contentedly upon its leaves. Still it is probable that the bulk of these insects found in Europe have been fed upon *Galium*, and are descended from ancestors whose diet has been similar. Hence we need not pronounce it an exception to Dr. Weismann's law if *C. elpenor* and *C. porcellus* have only doubtful diagonal bands, and *C. celerio* none at all. The strongly-marked diagonal pattern of *Sphinx ligustri* may seem unsuited to a species living on so narrow-leaved a shrub as the privet, but the larva feeds also upon the lilac and the ash. The large blue eye-spots of *C. nerii* are explained as resembling the flowers of the periwinkle, on which it is said to feed in this country. On the coasts and in the islands of the Mediterranean, which may be considered its true home, it feeds generally—some authorities say exclusively—upon the oleander (*Nerium*), from which it takes its name, and whose flowers are well known to be red.

The conclusion most readers will draw from this section is that the colouration of caterpillars is either protective—calculated to withdraw them from observation—or warning, those which are unsavoury, mal-odorous, or possibly poisonous, being strikingly conspicuous.

The author's account of ants, based on prolonged experiment and observation, is exceedingly valuable. Though he has not succeeded in verifying all the marvels told of "our six-footed rivals," he yet assigns them "a degree of prudence superior to that of some savages." If he cannot urge that "ants must be moral and accountable beings" it is because he has elsewhere attempted to show that, even with reference to man, the case is not by any means clear. His observations as to the effects of different coloured light upon ants seem to show that these insects have the power of distinguishing colour, that they are exceedingly sensitive to violet, and that their sensations of colour must be very different from those produced upon us. In this respect, if we may trust the conclusions drawn in the first of these lectures, they differ remarkably from bees.

The last two lectures deal with archæological subjects. Here, as might be expected, Sir J. Lubbock urges upon his hearers the importance of more efficient steps being taken for the preservation of our national antiquities—a question to which the legislature has unhappily so far turned a deaf ear.

For all those who have not time and opportunity to consult the original memoirs this volume will prove at once pleasant and profitable reading.

The Relations of Mind and Brain. By H. Calderwood, LL.D., Professor of Moral Philosophy, University of Edinburgh. London: Macmillan and Co.

The object of this book is to decide the relative claims of the two well-known rival theories of mental life. Is a physiology of brain and nerve a philosophy of thought, emotion, and will? A school of inquirers—numerous, able, and influential—reply to this question more or less distinctly in the affirmative. Thought is by some said to be a result of the brain, just as is bile of the liver, or urine of the kidneys. Others contend that if brain-power and mind-power are not identical, the one is nevertheless a measure of the other. These views the author examines in the light of recent physiological investigations. From an anatomical comparison of several of the best-known animal species,—such as the rat, the rabbit, the cat, the dog, the horse, the monkey, the ape, the elephant, and the whale,—he concludes that intelligence and brain-complexity do not keep pace. Whilst we accept this proposition, supported as it is by evidence drawn from the comparison of different individuals and races of our own species, we must demur to the author's standard for estimating the comparative intelligence of animals. He takes as a test "the results of training when an animal is brought under the influence of man." In virtue of this test he considers the dog entitled to a higher mental rank than the monkey and the ape. But in our own species we are apt to consider the readiness with which an individual or a race submits to slavery, a proof of inferiority. The comparison, too, is utterly unfair; the dog's forefathers have for many generations been placed in close contact with man, while the monkey is rarely born in captivity, and is studied under all the unfavourable circumstances of a climate unsuited to his health. Man is apt to extol those animals which make themselves the accessories of his vices, and to undervalue such as cling to independence. The best instance in favour of Mr. Calderwood's position—the ant—he has overlooked.

Elaborate brains, he considers, are indicative of a highly-developed muscular system. The instances given seem to us to involve some misapprehension:—"There is the brain of the horse, whose muscular power has come to afford the standard by which we estimate the comparative power of the steam-engine. There is the brain of the anthropoid ape, whose muscular power is such that when full grown a single stroke of its arm causes certain death to a man. There is the brain of the whale, so wonderfully minute in the windings of the convolutions as to be quite singular in this respect; an animal the mere stroke of whose tail can endanger a large ship."

Passing over certain fishes, such as the rays, and the large serpents, as the python and boa, whose brains are simple in structure, but whose strength is certainly no less striking, bulk for bulk, than that of any of the animals here mentioned, we ask if the highly-developed brain of the gorilla is the cause, or even the mark, of its great muscular power, why should man, with a brain still more elaborate, be so much weaker? The demands of the human brain upon the system have by some been alleged as the best explanation of man's remarkable muscular feebleness. However this may be, the author shows, from the independent researches of Ferrier and Hitzig, that a large portion of the brain—including most of the region assigned by Gall, Spurzheim, and their disciples, to the "moral faculties"—is connected with the sensory and motor activity of the nervous system, and serves consequently to regulate the movements of the body. Other portions—the so-called "silent" regions, comprising the frontal lobe—have not been found to respond to the stimulus applied, and their functions are consequently still unascertained. We cannot help here remarking how completely the once dominant system of phrenology has fallen into discredit in its old head-quarters.

The power of emotion, and of intelligent interest to affect the bodily condition, is discussed at some length, and is, in our opinion justly, regarded as a proof that the mind is something more and other than a mere corporeal function. We may give two facts in point, not adduced by Mr. Calderwood, and both taken from the history of exploring expeditions in savage countries. So long as the party is still advancing, and the minds of the men are engaged with novelties, seen or hoped for, their health is generally fair. But the moment it becomes necessary to return, and pass through scenes already traversed, a break-down is not long in making itself manifest. Again, the naturalists or other scientific men attached to such expeditions generally show a higher power of resisting malaria, fatigue, &c., than do their companions.

A most interesting incident is quoted from Kruse. "A deaf and dumb boy was in 1805 found by the police straying about Prague, and was placed in an institution for deaf-mutes, where he received instruction. When sufficiently educated to give accurate answers to questions put to him, he gave a description of his former life. His father, he said, owned a mill; he described the furniture of the house and its surroundings minutely; he gave a full account of his life when at home; told that his mother and sister had died, and that his father had married again, and that his step-mother ill-treated him until he had run away. But he neither knew his own name nor that of the mill; he knew, however, that it lay to the east of Prague. Enquiries were made, and the statements of the boy were found to be correct. The police found his home, gave him his proper name, and secured him the succession to his father's property." We think that this case alone is sufficient to warrant the rejection of Prof. Max Müller's celebrated dictum—"Without speech no reason."

The author's weak point is his evident desire to exaggerate the distinction between man and the lower animals. That among the latter, even in the wild state, there exists a conception of duty which in the rook, the ant, and perhaps in other species, takes the form of positive law, is proved by undeniable facts. In such animals, just as in man, though to a less extent, desire is checked by will and reflection.

Mr. Calderwood holds that prior to maturity of brain development "a child four years of age is found to concern itself with rational laws of life, insisting that deceit is wrong, and injustice and cruelty." Where such correct moral judgments are formed we may be sure that hereditary impressions have come into play.

Whilst, however, holding that the author has fallen into not a few errors of detail, for want of a closer knowledge of animal life, and that he has omitted certain considerations which might have been usefully brought forward, we fully admit that he has made good his main point, and has done useful service in drawing attention to the baseless assumptions of modern "somatism." We feel it a pleasant duty to acknowledge the spirit of candour which pervades the book, and its freedom from the *odium theologicum* and that kindred and equally bitter weed *odium philosophicum*.

The Aborigines of Victoria. With Notes relating to the Habits of the Natives of other parts of Australia and Tasmania. Compiled from various sources for the Government of Victoria, by R. BROUGH SMYTH. In Two Vols. Melbourne: J. Ferres, Government Printer. London: Trübner and Co. G. Robertson.

WE have here a most valuable contribution to the fashionable science of ethnology. The author, having been for sixteen years Secretary to the Board for the Protection of the Aborigines, has enjoyed exceptional facilities for obtaining information on the customs and peculiarities of the "black fellows." In addition to the results of his own personal observation, he has placed himself in communication with magistrates, missionaries, surveyors, frontier settlers—with all, in short, who, either from their position or their predilections, were able to throw light upon his subject. The outcome of this prolonged labour is a work which in another half century it would be impossible to produce. Mr. Smyth, indeed, modestly characterises his production rather as a "series of sketches" than as a "scientific work pretending to completeness." Still it will be found that he has proceeded in a systematic manner. He describes the physical and mental character of the natives, their numbers and distribution, the education and training of the young, their marriage laws, the disposal of the dead, their daily life, their food, diseases, dress, weapons, tools, and canoes. He then passes over to an account of their legends and mythology. The second volume is dovoted to the languages of the Australian tribes, and embraces a series of appendices by various contributors and an account of the extinct natives of Tasmania.

The principal shortcomings which we perceive are a proneness to needless repetitions, and a manifest tendency to defend, and even to eulogise, the "black fellows," which the facts and incidents brought forward scarcely warrant. Thus after adducing abundant testimony as to the generality of infanticide among the natives, and stating—on the authority of Mr. W. E. Stanbridge and Mr. P. Beveridge—that "new-born babes are killed by their parents and *eaten* by them and the (older) children," and that "*meals* are too often made by mothers of their own offspring;" after adding that this custom is not a rite, not a sacrifice, he yet feels free to remark that "every newspaper one reads gives accounts of cases of infanticide, as practised by our own people, *far more horrible* than any known to the Australians."

Elsewhere we read that the Australian native has not, like ourselves, had the advantages of thousands of years of civilisation; "he is as he was created!" Whether this dictum agrees worse with the evolutionist or with the specialist view of man's origin it is difficult to say. If we read the author's description of the horrible initiatory rites undergone by Australian boys before they are admitted to rank as men—rites consisting of five successive mutilations, in the last one of which the back, from the shoulders to the hips, is deeply furrowed with sharp flint-stones; if we further study the account here given of their complicated and oppressive marriage customs, their avoidance of different kinds of food,—not as unwholesome or contaminating, but merely as restricted to some one sex or some particular time of life,—we shall certainly be forced to conclude that the native is assuredly not "as he was created," but has either retrograded or "progressed" in a very undesirable manner. Indeed it is difficult, on Mr. Smyth's own showing, to avoid the conclusion that the life of an ape is more wholesome and less irrational than that of a "black fellow."

The exceedingly involved and complicated nature of Aboriginal customs is, however, a most interesting fact. It reminds us of the parallel circumstance that in a state of barbarism, or at the first dawn of civilisation, mankind have generally spoken highly complicated languages distinguished by manifold inflections, and have gradually, as they advanced to a higher culture, tended to a greater simplicity in speech. Do we here recognise a phenomenon of a periodic nature? Or are the savages whom we now meet with not in their upward course from the primitive condition of man, or of the anthropoids, but engaged in a career of degradation, such as we unquestionably meet with in various parts of the animal kingdom? From whichever point we regard it the question is beset with difficulties.

A most useful lesson which may be drawn from the work before us is, that the life of a savage is not, as the ignorant imagine, a career of freedom. What with the council of old men, the dreamers and conjurors, and the inviolable customs and superstitions of his race, the individual black fellow is at every step restricted and interfered with. The most searching civilised tyranny—with the redoubtable Mrs. Grundy as a make-weight—is, in comparison, liberty. There is another conclusion which we cannot refrain from drawing: superstition is often represented as the outcome of religion. Yet of the Aborigines, who are the most abject slaves of superstition, we read here—"I never could discover anything among them approaching to religion."

As one of the attributes of the Aborigines we learn that bodily deformity, in its various phases, is among them substantially unknown. Since we find, however, that deformed and weakly children are invariably destroyed, the absence of physical imperfection is not wonderful,

The author, if we misunderstand him not, seems to consider the "black fellow" as superior to the Malay, the Polynesian, the Chinese, and to the dark races generally. Thus he writes:—"In talking to a clever Australian native one feels that one is speaking to a person who has all the faculties (though undeveloped) of a European; but the Polynesian, the Malay, and some others, have always seemed to me to belong to races having little or nothing in common with the European." Yet whilst thus admitting racial peculiarities, he quotes, with seeming approval, John Stuart Mill's outburst of abuse against the doctrine of heredity.

A very remarkable physical characteristic is put on record. At the Coranderrk Station children from six to ten years of age have "hair on their backs one inch long and more, and as close as it can sit." The absence or scantiness of hair on the human back has been advanced by high authorities as a difficulty in the way of admitting the descent of man from the anthropoid apes. But if the above account is fully verified the difficulty is greatly reduced.

A new light is also thrown on the origin of the dingo, or wild dog. It has generally been considered to have sprung from stray dogs introduced by the first English settlers, and Mr. Wallace hesitates to recognise it as truly indigenous. The author, however, informs us that bones of this species have been found at the depth of more than 120 feet, beneath beds of clay over which lay volcanic ash. At Lake Timboon its remains have also been found in company with extinct species, such as *Macropus Titan* and *M. Atlas*. The presence of a truly native placental animal in that quarter of the globe is certainly a puzzling anomaly.

It will be seen that the chief merit of this work is as being a rich storehouse of facts and observations. When the author attempts to generalise he is less happy.

We cannot conclude this brief notice without calling attention to the munificence of the Victorian Colonial Government in endowing the learned world with a book so admirably got up and so profusely illustrated.

Journal of the Society of Telegraph Engineers. Vol. viii., No. 27.

The last number of this Journal contains reports of the meetings of the Society held on the 12th and 26th of March and the 14th of May respectively. The more important articles are those on "The Means of preventing Induction upon Lateral Wires," by Prof. Hughes, which has an important bearing on the practical employment of the telephone; on "South African Telegraphs," by J. Sivewright, M.A., giving an interesting account of the peculiar local difficulties which the telegraphic engineers have to put up with in these wild regions, their great enemies being the bullock waggons, which knock down their posts and their drivers who make "contact" with their immensely long whips. The bulk of the number is, however, occupied by a very valuable and complete paper by the Honorary Secretary, Colonel Frank Bolton, extending over nearly seventy pages. The excitement caused by the recent more or less successful application of the electric light to the purposes of every-day life has raised up a swarm of would-be inventors, who put forth as new inventions of questionable value which had long since been comfortably interred in the vaults of Her Majesty's Patent-Office; these have been resuscitated and re-patented, only to be once more left to their fate. One of the first things a reasonable inventor would do (and there are such) would be to enquire whether his invention was original or not. In this enquiry he would be met by a formidable obstacle in the fact that the last Abridgments of Specifications relating to Electricity do not go beyond 1866, and that even the very Specifications themselves are always months behind-hand. So late, indeed, as May 14th of the present year it was impossible to ascertain clearly the details of any patent on electric lighting later than those of last year. Our inventors consequently would be obliged to search through the whole of the electric patents from 1866 to the present time, a task the formidableness of which can only be known to those who have gone through it. Col. Bolton has therefore endeavoured to supply the unaccountable shortcomings of the Patent-Office officials, as far, at any rate, as the electric light is concerned, by publishing in a classified list a series of copious abstracts of the Specifications of all the Patents in any way relating to the electric light which have been taken out since 1841, as well as short descriptions of all the discoveries connected with it which have been made since Faraday first procured a spark from a revolving magnet, the whole being brought down to the present time. Col. Bolton divides his subject into two parts:—I. Dynamic and Magneto-Electric Machines. II. Lamps, each part being again divided into sections, devoted to a particular type of machine or amp. Most of the sections are preceded by a short account of the peculiar characteristics of each type of machine or lamp.

With regard to the manner in which Col. Bolton (who acknowledges the valuable assistance rendered him by Prof. Ayrton) has performed his irksome and laborious task we can only agree with Major Webber, who proposed the vote of thanks customary on such occasions, "that the Paper may be looked upon as an epoch on the question of electric lighting." Electricians who are ambitious of discovering the light of the future have now a point from which to start, and Col. Bolton's Paper will not only prevent them from re-inventing abandoned inventions, but will stimulate discovery by showing where, and possibly why, their predecessors have failed.

The Paper is illustrated by eighteen figures.

An Introduction to the Practice of Commercial Organic Analysis, &c. By Alfred H. Allen, F.C.S., &c. Vol. i., Cyanogen Compounds, Alcohols, and their Derivatives, &c. London: J. and A. Churchill. 1879.

Mr. Allen deserves the thanks of chemical students for having brought together within a small compass a large amount of information relating to the proximate analysis and detection of the better-known organic products used in every-day life, such as glycerin, carbolic acid, quinine, &c.

The Introduction gives instructions for the preliminary examination of organic substances in general. The body of the work begins with the particular examination of such substances as the cyanogen compounds; methylic, ethylic, and amylic alcohol, and their derivatives, acid, alkaline, and neutral; glycerin; the chlorals and chloroform; the vegetable acids; and, lastly, the phenols and their acid derivatives.

The general method in which Mr. Allen treats each substance is to first give its formula, and then its method of preparation, its physical and chemical properties, and the characteristic tests for distinguishing its presence and estimating its quantity. We think, however, that Mr. Allen has unnecessarily added to the bulk of his book by giving a number of details respecting the substances of which he treats, which are to be found either in the worker's memory or in any of our common text-books. He seems to have forgotten that his book is a working manual of analysis, and not a descriptive treatise. The four pages on Ultimate Organic Analysis, too, might have been replaced by a few lines giving the bibliography of the subject. There is an excellent table showing the fusing- and boiling-points, specific gravities, &c., of over fifty of the better-known organic substances. A copious index ends the volume.

CORRESPONDENCE.

EXTRAORDINARY SEASONS.

To the Editor of the Monthly Journal of Science.

SIR,—Perceiving an article on "The Anomalous Season" in your Journal, I forward you the following paragraph from the "Kentish Express." Neither of the seasons therein mentioned agree with an eleven years' cycle. The hot, dry season, 1818, is distant only seven or eight years from the two next similar seasons, viz., 1825-26, and if we add a successive period of eleven years to 1818 we get the series 1829, 1840, 1851, 1862, and 1863, which were certainly not seasons noted for heat and drought. A ten-years' cycle would include 1858 and 1868, which were both fine.—I am, &c.,

A CONSTANT READER.

"Mr. Shadrach Luckhurst, of the Charity Estate, Willesborough, a retired agriculturist, who for a period embracing a long life-time was engaged in farming the parish of Hinxhill, thus writes of one or two past seasons within his recollection. He says:—'1816 was a year never to be forgotten as the wettest, coldest, darkest, and most unfruitful on record. An immense quantity of corn never came to perfection, but blackened, mildewed, and rotted on the ground. The summer of 1818 was the longest, hottest, and driest I ever remember. A hilly field facing the south was sown with wheat in the autumn of 1817. It was cut fully ripe on June 29th, thrashed on July 3rd, ground on July 4th, and bread was made from the flour on the same day. This was the earliest wheat I ever saw. In this year the harvest was general by July 7th, and it was all cut and cleared by the 25th of the month. The whole country was of a uniform brown colour; not a blade of grass, not a turnip or cabbage was to be seen. Cattle perished for the lack of pasturage and water. For all that the year was the most plentiful, fruitful, and prosperous within my recollection."

PROCEEDINGS OF SOCIETIES.

Royal Society, *June* 19.—"Note on 'Spectroscopic Papers,'" by G. D. Liveing, M.A., Professor of Chemistry, and J. Dewar, M.A., F.R.S., Jacksonian Professor, University of Cambridge. In a recent communication to the Royal Society, Mr. Lockyer has criticised the author's statement of Young's wave-lengths identifications of certain chromospheric lines. As to the wave-lengths, the authors throughout their table omitted all figures after the decimal point merely for the sake of not cumbering the table. The numbers, Young mentions, are not his own, but taken from Angström's catologue. Moreover, as to Young's identifications with metallic lines, he states expressly that they were taken from the maps of Kirchhoff, Angström, and Thalén, and Watts's "Index of Spectra." Their object was not to criticise Young's work, but only to use it for the purpose of comparing the behaviour of certain metals on the earth and in the sun, and the conditions under which certain lines appear, or do not appear, or are reversed. They mentioned, in relation to aluminium, the two lines with wave-lengths 6245·4 and 6237·3 seen by Young, not because they thought their identity with the aluminium lines proved, but because they are the only two lines in Young's table which are at all close to aluminium lines, and if they be not due to that metal, then there is the remarkable fact that aluminium in the sun gives no lines either dark or bright except the two which have been reversed on the earth. A somewhat similar remark applies to the potassium lines, only in that case Young's line has a wave-length very nearly the mean of the two potassium lines which are often seen as one, not merely from want of dispersive power (which with prisms is usually sufficient at the violet end), but because the lines are expanded until they meet. The authors at first saw them reversed as one broad line which divided in two as the potassium evaporated. The authors never set themselves to determine exact wave-lengths; but they sought to determine the conditions of reversal, and they used wave-lengths for the convenience of indicating the lines of which they wrote. In general they determined the identity of a dark line with the corresponding bright line by observing that both had the same place on the cross-wires, or pointer, or both gave the same reading of the scale of the spectroscope. They then gave the wave-length of the bright line as determined by some good authority, usually either Thalén or Boisbaudran. When they could not identify the dark lines in that way, they took the readings of known lines with their spectroscope, using, for lack of sunshine, most frequently Boisbaudran's method and wave-lengths, and having drawn a curve, determined the wave-lengths of the dark lines therefrom. It was in this way that they obtained the wave-lengths of the two dark lines they ascribed to potassium. It is, of course, just within the bounds of possibility that the line for which they obtained the wave-length 4045 may have been an iron line reversed, but, as the principal well-known lines of potassium were at the same time seen bright in the spectrum while those of iron were not seen, it is far more probable—almost certain—that the line was really due to potassium, and the last figure of the wave-length wrongly determined. To attempt to determine wave-lengths to any greater degree of nicety would, so far as their purpose was concerned, have been labour thrown away. Whenever the wave-length of a line observed by the authors to be reversed is given differently from that given by Thalén and that given by Boisbaudran for the bright line to which they assume it to correspond, it was determined in the way above described. The authors state that by their method of working the very high dispersive power required for the specific identification of any substance by the determination of an individual wave-length is avoided; as they depend on the greatly diminished likelihood of error when several groups of lines of the same substance are seen to be continually present at the time of one or more reversals. It was the necessity of being able to rapidly sweep the entire spectrum for the above purpose that caused them to limit the dispersion. A large majority of the wave-lengths given by Thalén were obtained by means of the moderate dispersion of one bisulphide of carbon prism, a less dispersion than we have used; and they consider it would be incorrect to suppose that no enduring work in this field of spectroscopy can be effected except with the enormous dispersive power which Mr. Lockyer recommends.

"Microscopical Researches in High Power Definition," by G. W. Royston-Pigott, M.A., M.D. Cantab., F.R.S. In its general scope the paper is intended to deal with difficulties in microscopic research, usually found insuperable—such, for instance, as the invisibility of minute *closely packed* refracting spherules, existing in double rouleaux, or promiscuously aggregated; when their individual diameter varies between the 1-80,000th to the 1-200,000th of an inch. These difficulties are principally created by overlapping images—due partly to residuary aberrations both spherical and chromatic—partly to the effects of diffraction, caused by brilliant illuminations of spurious disks of light—partly to the constant development of Eidola or false images, which vary the loci of their development according to the nature of underlying structures; and according to the object-glasses being over or under corrected—and partly, and indeed very considerably, created by the use of excessively large angular aperture. The paper discusses also the relative effects on visibility, of large and small angular apertures in objectives. It shows that the black margins or black marginal annuli of refracting spherules, constantly displayed by low aperture glasses, are attenuated gradually to invisibility as the glasses employed are endowed with the largest apertures. That the black margins also of cylinders, tubules, or semi-tubules suffer similar obliterations. And that, in consequence, innumerable minute details are concealed or destroyed till the aperture is sufficiently reduced. That minute refracting bodies obey the laws of their refrangibilities and display beautiful phenomena, discoverable by transcendent powers of definition; but totally unseen by inferior compensations. And that, in consequence, the so-called achromatism of modern glasses is an illusory approximation to correct vision. Examples are given of molecular structures, varying in form, translucency, and refrangibility, in which natural pencils are caught and displayed in the order in which, as in a rain drop, iridescent rays are emitted by the decomposed light. Several examples are also introduced, in which a high order of lenticular correction beautifully discovers structure hidden, according to Dr. Carpenter, F.R.S., from the great bulk of observers. As the paper deals so often with magnitudes very much less than the 1-100,000th of an inch, a method is introduced of readily estimating roughly such magnitudes between the 1-80,000th and the 1-500,000th of an inch, by means of a micrometer gauge. The writer has been emboldened to grapple with these difficult minutiæ, in consequence of the sharp and clear definition he has attained of spider lines miniatured down to the fourteenth part of a hundred-thousandth of an inch. The eye, accustomed to contemplate this subtlety of form, readily appreciates the one-fourth or sixth of this size—*i.e.*, 1-400,000th or 1-600,000th. The writer has also brought before the notice of the Royal Society a new test for the microscope, displaying bright lines of uniform thickness less than the 1-100,000th, and sharp black lines of much less tenuity than those given by Nobert's celebrated lines ruled on glass, and incomparably more easy of illustration. The employment of various fluids for immersion lenses is carefully considered; and the singular property of castor oil discovered by the writer is referred to. But, as the author's paper on "A Searcher for Aplanatic Images" was inserted in the "Transactions," he now introduces a new form which offers some advantages: by its extended traverse, by its simplicity and economy of light with increase of magnifying power. Finally, some examples are given of producing transcendent definition in cases found hopeless by a numerous body of observers. The means also of its attainment are minutely described.

"Preliminary Note on a new Tide-predictor," by E. Roberts, F.R.A.S. The Indian Survey Department having under-taken the superintendence of tide-registration around the whole sea-board of India and at the port of Aden, and also the reduction of the observations by the method of harmonic analysis, with the view to the prediction of tides for the whole of the ports, it became a matter of necessity, in order to save the large outlay which the numerical operation of their prediction would have involved, that an instrument should be constructed to delineate the predictions. Accordingly, on the recommendation of the Surveyor-General of India, Mr. Roberts was desired to design, and to undertake the construction of, an instrument to include such a number of tide-components sufficient to predict the Indian Ocean tides with all the accuracy necessary for practical purposes. The present machine is the outcome of the recommendation. The instrument combines the following twenty tide-components:—The mean lunar semidiurnal, the first and second overtides of the mean lunar semidiurnal, two *elliptic* lunar semidiurnal, two *evectional* lunar semidiurnal, one *variational* lunar semidiurnal, the mean solar diurnal, the mean solar semidiurnal, the luni-solar-semidiurnal, the lunisolar diurnal, the lunar diurnal, the solar diurnal, one lunisolar elliptic diurnal, one lunar elliptic diurnal, one compound (Helmholtz) lunisolar semidiurnal, one compound (Helmholtz) lunisolar quarter-diurnal, the solar annual, and the solar semiannual. The chief difficulty in the construction of the machine is the finding, within reasonable limits, of proportions which shall represent with sufficient accuracy the periods of the several components, in order that the machine may be used for a considerable period of prediction—say, for twelve months. Very great success has been attained in this respect in the present instrument. For instance, the error of the period of the chief component (the mean lunar semidiurnal) relatively to the mean solar semidiurnal is inappreciable during a whole year's predictions, amounting to about 0·10° only in a period of fifty years. The largest deviation from strict accuracy is 0·37°, after a run representing twelve months. This is, however, of one of the very small components, and insensible in its results. This part of the design may be therefore regarded as practically perfect. The setting of the machine for the prediction of the tide-curves of any part for which the tide-components are known is as follows:—The dials are first turned so that the epoch or time of maximum is exactly under or above the highest or lowest point according as the component is situated on the upper or lower row of components. The cranks are set vertically (the slotted cone of the wheel on the axis having been first released) and the guide-pin thrown out to its proper range to represent the half-amplitude of the component. The proper positions of the hands having been previously determined by calculation for the time of starting, the hands are set and the slotted cones tightened up. The recording barrel is then set to the time and the wheelwork set in motion. The complete setting occupies only a few minutes.

PHYSICAL SOCIETY, *June* 14, 1879.—Prof. W. G. Adams, President, in the chair.

Prof. Macleod described a plan for Suppressing the Induction Disturbances in a Telephone Circuit. The method suggested is the employment of a shunt consisting of a cell containing platinum plates or wires in very dilute sulphuric acid. The induction currents on the line, having a high potential, escape through the shunt to earth, while some of the telephonic current passes to the telephone. In this way the induction currents are entirely removed, while the sound of the voice is only weakened.

Dr. O. J. Lodge exhibited his New Reversing Key for Electrometer Work, which is preferable to the ordinary forms, as giving a high insulation, small capacity, and not requiring the hand to approach close to it to work it. It consists of four platinum wires, arranged in pairs crossing one another; one pair crossing between the other two. These are the terminals and contact pieces of the key. The middle pair are supported by an endless silk thread, which runs on two pulleys, one of which is fitted with a handle. On turning the handle to right or left the two middle wires are brought into contact with one or other of the two outer wires, and the current reversed at will. The whole is enclosed in a metal box.

Mr. J. F. Moulton then demonstrated the results of the experiments of Mr. Spottiswoode and himself on the Sensitiveness of Electric Discharges in vacuum tubes (see "Monthly Journal of Science," 3rd series, vol. i., p. 443).

June 26.—Earl Rosse in the chair.

An extra meeting of this Society was held on the above date at Cooper's Hill Indian Engineering College on the invitation of Col. Chesney, R.E.

Prof. Unwin, of the College, read a paper on "Experiments Relating to the Friction of Fluids on Solid Surfaces against which they rub." It has long been known that a board dragged through water suffers a resistance varying in some way as the square of the velocity, that a stream has a uniform motion at such a velocity that the component of the weight of the water down its inclined bed is balanced by the fractional drag on the bottom. The fluid in the neighbourhood of the stream is known not to move as a solid mass, the centre moving faster than the sides, and the different fluid layers rub against each other. The adhesion of the fluid to the solid, against which it moves, also gives rise to a sliding or shearing action. Our knowledge of the subject has hitherto been gained from observations on pipes, streams, and from the experiments of the late Mr. Froude with a plank of wood drawn through the water of a canal. It is desirable to have a set of laboratory experiments, however, as the conditions can be varied more than can be done by such methods, and for this purpose the author had designed a special apparatus. In Mr. Froude's experiments there was a practically unlimited mass of water and a definitely limited extent of solid surface; and his results are not free from certain anomalies. The author thought it might be instructive to try the other case of a limited mass of water, and a virtually unlimited surface; a disk in rotation gives such a surface. In some respects a cylinder would (as suggested by Prof. Ayrton) be the simplest to treat theoretically, but there are experimental difficulties in its way. The apparatus of the author consists of a metal disk rotated on a vertical axis in a vessel of water; and the problem is to determine its resistance to rotation, since this will be equivalent to the water friction upon it. Within the outer vessel is placed a thin copper chamber, the diameter of which is unalterable, but the depth is variable at pleasure. The disk is placed concentrically inside the chamber, where there are two cheese-shaped masses of water, one above and one below the disk, which are dragged into rotation next the disk and retarded next the sides of the pan. The couple required to rotate the disk is equal to the couple exerted by the disk or the fluid when the motion is uniform. Hence the tendency of the chamber to rotate is measured by suspending the latter from three wires in a manner similar to the bifilar suspension of magnets. An index marks whether it rotates or not on a graduated scale, and a weight suspended by a cord measures the force required to keep the index at zero. Let M be the moment of the fractional resistance of the disk; N the number of revolutions per second. Then $M=CN^x$, where C and x are constants. The author has obtained a number of results, which are, however, not yet ready for publication. He mentioned, however, that a rough cast-iron disk has a frictional resistance almost exactly as the square of the velocity; whereas a turned brass disk gave a value of x decidedly less than 2. The resistance is a little greater when the mass of water is larger. These results were calculated for a speed of 10 feet per second. The author hopes to try the effect of temperature, &c., on fluid friction, and viscous as well as thin fluids.

Prof. Unwin also exhibited a piece of apparatus with which he hopes to study the stress of rivetted plates under shear by means of elastic substances, such as caoutchouc. He purposes to stretch the rivetted caoutchouc and photograph the appearance of stress-lines upon it.

Lieut. G. S. Clarke, R.E., explained the process invented by Prof. McLeod and himself for determining the absolute pitch of tuning-forks (see "Monthly Journal of Science," 3rd series, vol. I., p. 257).

Prof. McLeod then described an electric clock used in the experiments on tuning forks. A zinc and steel compensating pendulum moved by its own gravity; but at each beat made and broke a battery circuit by means of two bent springs, one on either side. The current passing through an electro-magnet detained a bent lever until the pendulum swung to the other contact. By this contrivance time was marked. Prof. McLeod found that the platinum contacts frequently stuck together in these experiments; but this defect had been cured by the use of a liquid shunt of dilute sulphuric acid, which destroyed the extra current. This remedy had been suggested to him by Lord Rayleigh. Prof. McLeod demonstrated the complete success of this device, which acts as well as a condenser shunt. He had also observed a curious effect with these liquid shunts, which as yet he could not explain. Two shunts, having the same acid in both, were employed, one shunting the extra current from four Daniell cells and one that from two Daniell cells. The first showed evolution of H and O gas, the platinum electrodes being unaffected. The second showed no evolution of gas, but one platinum plate was dissolved away and deposited in a black powder on the other. He also exhibited a new cell formed of zinc and mercury plates, with zinc iodide solution and mercurous chloride salt. Red iodide of mercury is formed at the negative electrode. The E.M.F. is seven-tenths of a Daniell-cell, but the interval resistance very low and the cell very constant, while there is no local action.

Prof. Guthrie suggested that as the extra current was really a succession of sparks the platinum might be carried bodily over from one electrode to the other.

Mr. F. H. Varley stated that Mr. F. Higgins had observed a similar effect with carbon electrodes in a voltameter, one carbon falling away into a fine powder, and due perhaps to the disintegrating action of liberated gases. He had also himself seen a platinum wire in contact with a carbon one eaten thin and drawn into very fine silky pens, while the carbon was stained blue, although the current passing was of low tension.

Mr. Chandler Roberts suggested that perhaps a hydride of platinum was formed in the case mentioned by Prof. McLeod.

Prof. Guthrie suggested experiments with fluorescent liquid shunts in the dark.

Mr. J. W. Clark then described some experiments on the surface tension of sulphurous anhydride sealed in a capillary tube within a second tube containing the same substance. He found that at low temperatures the level of the liquid is lower in the narrow than in the wide tube. As the temperature rises the meniscus in the narrow tube descends, till at about 156° F. it is level with that of the wider tube, both surfaces being slightly concave. About this temperature the surfaces become plane then concave, the level in the wide tube becoming higher than that in the narrow one. The experiments are being continued, and Mr. Clark's other results will be communicated to the Society later on.

June 28.—Prof. W. G. Adams in the chair.

Prof. W. G. Adams, the President, exhibited his new measuring polariscope. It consists of three principal parts. The lower section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of lenses and Nicol's prism arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope. Besides these there is a middle piece, consisting of two lenses (nearly hemispheres), forming a box to enclose the crystal immersed in oil, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned about the optical axis of the instrument. The vertical graduated circle carrying the central lenses and crystal may be turned through an angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle, with its centre at the centre of curvature of the central lenses, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystal and the central lenses can be turned abcut each by three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rims of the central lenses, the crystal and central lenses may be turned separately about the optical axis of the instrument, so as to bring the planes of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.

Sir John Conroy, Bart., read a paper "On the Distribution of Heat in the Spectrum." After referring to Dr. J. W. Draper's supposition that all the rays in the spectrum have the same heating effect, and to his statement that owing to the unequal dispersion of the prism for rays of different refrangibility the method that has been usual for determining the calorific intensity of the various parts of the spectrum is an essentially defective one, the author described a graphical method for eliminating the effect of the unequal dispersion of the prisms, and showed that from MM. Fizeau and Foucault's reassurements, and also from those of Lamansky and Prof. Tyndall, that the maximum intensity is about the middle of the visible spectrum and not at the red end; and, further, that the curves given by various observers as representing the intensity of the heat in different portions of the spectrum are, in reality, the "dispersion curves" for the particular prisms employed.

Captain Abney, R.E., called attention to his published paper "On the Measurement of the so-called Thermo-Spectrum," wherein he shows that the distribution of heat in the spectrum is a misnomer, and that what was really measured by Lamansky and Tyndall was the energy absorbed by the lampblack and the absorption due to the prisms used. He considered that there was no inherent heat in the spectrum. He found that Dr. Draper had not taken into account the amplitude.

Prof. Guthrie said that Captain Abney had expressed what many thought—namely, that heat was radiant energy.

Mr. Grant then described an investigation which he had made into the induction lines round two parallel coils of wire in the primary coil, an intermittent current of electricity from a Leclanché battery flowed; and in the secondary, a telephone was connected up to detect the induction sounds. With this apparatus he found that with the coils kept parallel to each other there were lines, or rather a surface of minimum induction, surrounding the primary, and that if the secondary were placed in these lines hardly any induction noise could be detected. A diagram, representing a medial section through the coils, showed the lines to proceed from the wire of the coils in two curves resembling parabolas, one from each cross section of the wire outwards.

Dr. Shettle then described his experiments proving the lines of force in a bar magnet to run spirally round the bar between the equator and poles, the equator being decentred and oblique across the bar, as shown by diagrams.

Prof. Rowland, of Baltimore, made some observations on the new theory of terrestrial magnetism of Profs. Ayrton and Perry (see "Monthly Journal of Science," 3rd series, vol. i., p. 287). He said the experiments on which the theory was founded had been attributed to Helmholtz, but they were entirely his own, he having gone to Berlin to make them. The new theory had occurred to himself on making these experiments, but he had rejected it because he found that the potential which the earth's surface would require to have would not only cause violent planetary disturbances, but by mutual repulsion drive objects off the earth. He had made also an experiment to see if absolute motion of electricity would cause magnetisation, but failed to get any effect from it. Then he resorted to calculation to find the magnetic effect of relative motion by rotation of a changed sphere of perfect magnetic permeability that is more magnetic than iron. He found that when the sphere was uniformly charged and rotating there would be a magnetic field in its interior; but, instead of the result of Messrs. Ayrton and Perry, that if the earth were charged to a potential of, he believed 10^8 volts relatively to interplanetary space, the earth's magnetism would be what it is, he found the necessary charge to be $61+10^{15}$ volts. In the ordinary atmosphere this potential would produce a spark nine million miles long, and discharge across to the moon. If the moon were electrified to the same degree, the mutual repulsion would overcome the force of gravity between them. He therefore considered terrestrial magnetism to be still a mystery. He had also thought that the aurora borealis might be explained by supposing the upper regions of the earth's atmosphere electrified. The winds carrying the upper strata towards the poles, electricity would condense there. This hypothesis is tenable still.

Prof. Ayrton said that whether or not the new theory of magnetism should be so rejected depended on whether or not Prof. Rowland's calculations, or those of himself and Prof. Perry, were wrong. It had been found by Sir William Thomson, from experiments at Arran, that the earth was electrified with respect to the air, and that there is a difference of potential of 30 volts between earth and air for each foot of ascent. This gave 1360×10^{12} centimetre-gramme second electrostatic units as the potential of the earth. The new theory required the potential to be 1011×10^{11}, or supposing the earth to be solid iron, or about 14 times more, a wide margin.

Prof. Rowland said he had not seen the calculations of Profs. Ayrton and Perry yet; but he believed his results to be correct, as he had checked them in various ways.

Mr. Bailley exhibited a modification of Arago's experiment, in which a copper disc is caused to rotate continuously by changing the polarity of four electro magnets underneath by a revolving commutator.

Mr. Conrad Cooke exhibited a single voltaic element showing the internal current. This is done by forming the glass vessel containing the element into a helical tube between the poles, and hanging a galvanometer needle in the interior of the helix: the internal current deflects the needle.

NOTES.

Biology.

It must be remembered that in addition to the animal and vegetable kingdoms certain biologists admit a third, the protistic kingdom, consisting of the lowest forms of life, holding a doubtful or intermediate position between animals and plants. As such Prof. E. Haeckel ranks the *Thalamophora*, *Radiolariæ*, *Myxomycetes*, &c. To such beings he considers it probable that a polyphyletic origin must be ascribed, the same forms having probably originated at different times and places. Vertebrate animals, including man, are clearly of monophyletic descent. From the *Amphioxus* to man they are the issue of one and the same ancestral group. As regards the Arthropods the case is less certain. Either the Tracheata are descendants of the Crustacea or the Arthropoda are in their origin diphyletic. Among the Echinoderma unity of origin appears certain, and among the Mollusca, again, it is the most probable. As regards the vegetable kingdom, the Phanerogams and the Prothallophytes are probably of monophyletic origin, whilst the Thallophytes are as probably polyphyletic. A similar distinction may be drawn as regards the organs of living beings. The author divides them into typical or semantic,—such as are peculiar to a single class, such as the dorsal cord and vertebral column of the Vertebrata, the tracheal system of the Tracheata, &c. These he considers as having been evolved only in one place and on one occasion. On the other hand, the asemic or atypical organs are found under analogous conditions in various groups, and may have originated independently in a number of cases. Instances are the locomotive, the sensient, and the sexual organs, the heart, &c. A similar distinction may be traced even in languages, the higher being of monophyletic origin and the latter of polyphyletic.

Dr. Bordier has communicated to the Anthropological Society of Paris the results of a comparative examination of the skulls of thirty-five murderers. All of them are of considerable size, resembling in this respect pre-historical crania, and having, like to them, a small frontal development with the parietal region predominating. These large cranial capacities are often associated with cerebral anomalies. The author had recently in his employment a man, decidedly below the average in intelligence, whose skull, after his death, exceeded 1500 c.c. in capacity. The brain presented a conformation peculiar to certain pachyderms. The skulls of murderers present a number of defects and anomalies. Dr. Bordier gives the history of some of their owners, in all of whom appears atavism, morbid activity, and a want of equilibrium between the frontal and the parietal faculties. Heredity is manifest in most cases.

M. Décharme describes in the "Comptes Rendus" a remarkable flight of butterflies (*Cynthia cardui*) observed at Angers on the 10th of June. It is calculated that 40,000 to 50,000 of these insects traversed the Rue du Mail, leading to the river, within an hour. They passed swiftly in a general direction from east to west, flying at the height of from 1 to 2 metres above the ground. A violent storm took place to the east and south of the town during the following night. On June 3rd M. Genevay-Montez observed a similar migration of the same species in the valley of the Rhone.

Dr. P. Mayer has laid before the Lyncean Academy his researches on the antennæ of certain Diptera, such as *Syrphus balteatus*, *Eristalis tenax*, *Musca vomitoria*, &c. He finds in the terminal joint certain cavities lined with a sensitive membrane, and serving as organs of smell or hearing.

Most naturalists who have had occasion to walk much about grass and stubble during August have been annoyed by the irritation caused by the harvest bug (*Trombidium autumnale*), an Arachnoid which buries itself in the skin and dies there, causing in most instances troublesome sores and much pain. In most cases the nature of the irritation is misunderstood, and the parts affected wrongly treated. Upon application to a country chemist some ammoniacal preparation is usually supplied, which fails to give relief as it would do to the sting of a gnat or wasp. The wound of the harvest bug should be treated as a sore containing putrid animal matter. The following lotion answers well:—Vinegar, 40 parts; Calvert's carbolic acid, 1 part: mix with an equal proportion of water before use, and apply to the parts affected: it not only heals speedily, but, from its strong and persistent odour, in a great measure prevents further attacks from the very annoying insect.

CHEMISTRY AND TECHNOLOGY.

Attention has been drawn to the presence of arsenic in dark water colours by the sudden death of a mechanical draughtsman. In the "Chemiker Zeitung" Dr. H. Fleck states that on a *post mortem* examination the cause of death was first supposed to be an oxalate, and then a narcotic poison. Chemical investigation, however, showed that the liver, kidneys, lungs, heart, and brain were impregnated with arsenic, though the œsophagus contained not a trace, and the stomach with its contents gave a barely perceptible arsenical mirror. The general circumstances of the case excluding the suspicions of suicide and of malicious poisoning, it was found that the deceased had been in the habit when drawing of passing the pencil filled with colour between his lips in order to point it. The water-colours he had used were analysed, and whilst indian-ink, gamboge, carmine, red eosin ink, neutral tint, &c., were found perfectly free from arsenic, a sample of sepia contained 3·08 per cent of arsenious acid, terra di sienna 3·14, and a reddish brown colour, the name of which was indistinct, 3·15. Burnt sienna, Vandyck brown, bistre, bladder green, brown ochre, indian red, umber (raw and burnt) were also found arseniferous. The exclusion of arsenic from such colours, in which it seems to play no essential part, should be insisted on by the authorities. Most of these colours are essentially iron lakes. Hence it appears that the mere presence of ferric oxide, except in a hydrated state and accompanied by free magnesia in quantity sufficient to neutralise the acids of the stomach, does not act as an antidote to arsenious acid. This case seems likewise to prove that arsenic taken in minute doses can accumulate in the system until it can be readily recognised in all organs, and can exert a dangerous action. The impunity with which the peasants of Styria consume small doses of arsenic would seem to depend upon circumstances not yet fully determined.

The "Apotheker Zeitung" gives the following formula for an ineradicable ink:—1·75 grms. aniline-black are ground up with 60 drops hydrochloric acid and 42 grms. alcohol, and the liquid is diluted with a hot solution of 2·5 grms. gum-arabic in 170 grms. water. If the aniline-black solution is diluted with a solution of 2·5 grms. shellac in 170 grms. spirit instead of gum-water, the result is an ink suitable for writing on wood, brass, or leather,

A letter from M. P. Truchot to M. Dumas concerning the apparatus of M. Lavoisier was read at a recent session of the Academy of Sciences. It appears that Lavoisier's chemical laboratory and physical cabinet have been reverently preserved by his family, and are now in the possession of M. E. de Chazelles, at Canière, near Aigueperse, Puy de Dome. The smallest of the three balances is sensitive to 1-612 grain. The weights belonging to these balances are wanting, but the kilogramme and its subdivisions as established by Fortin are present, recalling the fact that Lavoisier made all the determinations needful for fixing the weight of the kilogramme. There is a small model of an apparatus for the distillation of sea-water. There are a considerable number of precious stones, some of which have undergone the action of fire. Lavoisier is known to have made an experimental comparison of the heat produced by converging lenses with that of the blowpipe fed with oxygen.

With reference to the electric light superseding that obtained from coal-gas, Dr. Greiff contends, in "Die Chemische Industrie," that even supposing the gas manufacture should ultimately be abandoned, the tar colours could be prepared from the residues left on rectifying the petroleum of the regions on the Caspian. These are estimated at 120 million kilos. yearly, and are ten times richer in benzol and five times richer in anthracen than is coal-tar. The American petroleum has not yet been examined from this point of view, but it will probably also prove to be a rich source of aromatic compounds.

METALLURGY, MINERALOGY, MINING, &c.

In a Paper read at a Meeting of the Société de l'Industrie Minérale, M. Pourcel, after describing the rise and progress of the Thomas and Gilchrist method of dephosphorising iron, gives an interesting account of his visit to Messrs. Bolckow and Vaughan's works, at Eston, in May last, where the process was carried out in his presence. The method of working in no way differed from that described by Messrs. Thomas and Gilchrist, in their Paper read before the Iron and Steel Institute in May last. The prime conclusion which M. Pourcel draws from his investigations is that the dephosphorisation of iron in the Bessemer converter is an accomplished fact, and that the practical difficulties in the way of its industrial application may be surmounted by an attentive examination of the chemical phenomena which occur during the various operations.

A new application of rapid oxidation by which sulphides are utilised for fuel has been made by Mr. John Hollway, whose process has been fully described and discussed before the Society of Arts. This process has for its object the utilisation of the heat generated by the rapid oxidation of certain mineral substances which have not hitherto been used as sources of heat for smelting operations. The heat thus obtained is employed in the reduction of the furnace charge, which may be composed partly of sulphides and partly of silicious ores. A current of air is forced through molten sulphides, by which means they are very rapidly oxidised. Great heat is thus developed, rendering the process of smelting a self-supporting operation; therefore no extraneous fuel is required, excepting that employed in raising steam for the blowing engines; where, however, water power is available, steam can be dispensed with, in which case all the carbonaceous fuel necessary for the operation is a little coke to start the furnaces, which stands in the same relative position to the ores as wood does to coal in the lighting of an ordinary fire. The process may be defined as a system of fractional oxidation, in which the numerous constituents of a complex furnace charge can be separated from each other and concentrated in different parts of the apparatus, the heat necessary for the operation being obtained by the combustion of a portion of the less valuable constituents.

M. Galippe, in a paper read before the Biological Society of Paris, described the following experiment:—A rabbit received daily for six months a large dose of copper acetate. At the end of this time it was served up at the table of the learned chemist. The liver weighed 70 grms., and contained 13 centigrms. of copper. M. Galippe partook of it, and has suffered no inconvenience.

A new named metal, Norwegium, has been detected and isolated by Dr. Tellef Dahll in a sample of copper-nickel from Kragerö, in Skjærgaarden. The colour of the pure metal is white, with a slight brownish cast. When polished it has a perfectly metallic lustre, but after a time it becomes covered with a thin film of oxide. It can be flattened out in an agate mortar, and in hardness it resembles copper. The melting-point is 350° C., and the specific gravity 9·441. Its equivalent appears to be 145·9. Only one oxide, NgO, has been obtained. With sulphuretted hydrogen it gives a brown sulphide, even in strongly acid hydrochloric solutions, which re-dissolves in ammonium sulphide. With a slight addition of potassium ferrocyanide it gives a brown, but with larger proportions a green, precipitate. The sulphuric solution is turned brown on the addition of zinc, and the metal is deposited in a pulverulent state. The solutions of this metal are blue, but become greenish on dilution.

Two new phosphates, found at Skipton Caves, Victoria (N.S.W.), are described by Vom Rath in No. 79 of the "Bull. Soc. Min." (France). *Hannayite*—Triclinic, basal cleavage perfect; less perfect parallel to two prismatic planes; sp. grav., 1·893. Composition: phosphoric acid, 45·70 per cent; magnesia, 18·90; ammonia, 8·09; and water, 28·20 = 100·89 per cent. Loses, between 100° and 120°, 21·08 per cent water. *Newberyite*—Orthorhombic; cleavage brachydiagonal, perfect; basal, imperfect. Composition: phosphoric acid, 41·25; magnesia (by difference), 23·02; water, 35·73 = 100 per cent.

Huntilite, named after Dr. Sterry Hunt, occurs at the Silver Islet Mine, Lake Superior. According to the "Engineering and Mining Journal" it occurs in two varieties. The most abundant is amorphous, often porous; dark slate, grey, or almost black; dull. The crystalline variety is cleavable in one direction, and of a lighter slate-colour. The probable formula is $AsAg_3$.

The "Mineralogical Magazine" for July contains several interesting Papers, among which we may mention the following:—"Contributions towards a History of British Meteorites," by Townsend M. Hall; "Geognosy and Mineralogy of Scotland," "Preliminary Notice of Supposed New Scottish Minerals," and "On Haughtonite, a New Mica," by Prof. Heddle; "On some Gold Occurrences," by Rev. J. Clifton Ward; "Additional Note on Penwithite," "On Christophite from St. Agnes," and "On the 'Maxwell-Stuart' Topaz," by Mr. J. H. Collins; "On

Japanese Minerals," by Mr. John Milne; "Measurements of Angles of Basaltic Columns in Giant's Causeway," by Rev. J. H. Jellett.

According to the "Breslauer Zeitung" considerable deposits of sulphur are found in the gypsum formation of Upper Silesia, especially at Pschow and Kokoschütz, near Ratibor.

It appears from the Report of Prof. Burat on the Mine-Explosion at Frameries, given in "La Correspondance Scientifique," that more than 100,000 cubic metres of fire-damp must have been evolved in a very short time. All the two hundred safety-lamps (Mueseler's) were extinguished without causing ignition. The gas issuing from the shaft caught fire *outside* the mine (possibly from the engine furnace), and burnt with an enormous flame. When the supply was becoming exhausted the burning gas ran back into the interior of the mine, followed in its retreat by atmospheric air, and occasioned nine successive explosions. The whole occurrence is considered unexampled in the annals of coal-mining.

From the Reports of the Mining Surveyors and Registrars of Victoria we gather that the yield of gold for 1878 is estimated at 755,754 ounces, showing a decrease of 44,000 ounces as compared with 1877.

From a Paper on the Mineral Wealth of Turkey, in "Chemiker Zeitung," we learn that tin, cobalt, nickel, bismuth, and uranium are entirely absent. Chrome iron ore, emery, and copper are plentiful. Coal is found only in the basin of Eregli and Amastra on the Black Sea. There are numerous petroleum wells on the Persian frontier.

Referring to the grey modification of tin the same journal states that, according to Schertehl, tin, under certain unknown circumstances, becomes so brittle as to be crushed between the finger-nails, and has the sp. gr. 5·8. If boiled in water it recovers its ordinary colour and texture, while the sp. gr. rises to 7·3.

Chinese diamonds are, we are informed by the "Technologiste," chiefly brought from the province of Shantung. Men put on thick shoes of straw, and simply roam about the valleys and the rivers. The rough and pointed diamonds penetrate into the straw and stick fast. The shoes are finally collected together in heaps and burnt, when the diamonds remain in the ashes.

In a Paper on Amber M. Helm says that in entire fragments it is permeable to water. It contains as much as 4 per cent of sulphur in the state of organic combination. This sulphur has probably been absorbed by the fossil resin in the state of hydrogen sulphide subsequent to its formation. The author describes another fossil resin, gedanite, which differs from amber by containing a smaller proportion of oxygen, and is softer, more fusible, and more soluble in ether. It is free from succinic acid.

THE MONTHLY

JOURNAL OF SCIENCE.

SEPTEMBER, 1879.

I. THE CRIMINAL LAW OF THE FUTURE.

NOTHING is more common than for men to express an authoritative opinion upon subjects which lie remote from their ordinary sphere, and which they have never made the theme of serious study. Very frequently it happens that their lucubrations are received with more favour than are the writings of the specialist based upon the researches of a lifetime. We see for instances novelists, barristers, dramatists, statesmen, and the like, who have never worked for a single hour in a biological laboratory, come forward with the most charming confidence to solve such problems as the origin of organic species.

Hence surely it will not be deemed unpardonable presumption if a biologist, in his turn, attempts to apply one of the most recent principles of his science to an important social question—we mean to the treatment of crime.

It is well known that the general current of what is called the "spirit of the age" has tended in the direction of increasing leniency to offenders. Capital punishments have been abolished in some countries with but very unsatisfactory results, as may be seen in Italy, Switzerland, and Spain. In others they are greatly restricted, even in case of the most monstrous crimes. "Extenuating circumstances" in France and recommendations to mercy in England save many a villain from the gallows. Not content with this state of things, we have a "movement" and a society for the total abolition of the extreme penalty. What the next step will be if this is effected we know not, unless garotters, corner men, and ruffians in general are to receive a bonus for every unoffending person they maim or kill. It may perhaps surprise those who are so anxious for the path of crime to be strewn with roses, if they are told that the legitimate conclusions to be drawn from one of the most interesting laws of organic science point in an exactly opposite direction. How this can be the case will at once appear if we refer to one of the stock-arguments of the opponents of capital punishment. They sometimes remind us that if a locomotive explodes, occasioning damage and perhaps loss of life, we do not break it up for old metal, but send it to be repaired. It might, however, strike them that between the defective locomotive and the criminal, especially the murderer, there are points of distinction which make their parable worthless. Let us suppose these differences done away with. Suppose good locomotives were so plentiful that employment for many of them could not be found. Suppose bad locomotives could not be reduced to inactivity and consequent harmlessness at our will, but were all to go on of their own accord, working and doing damage. Suppose, further, that if sent for repairs to a competent engineer we had still no positive means of knowing whether they were rendered trustworthy, or whether their defects were merely hidden for a time, to re-appear on some future occasion. Lastly, let us suppose that these unsafe locomotives had the power of reproduction, giving rise to others no less dangerous than themselves. Were such the case common prudence—the instinct of self-preservation—would at once bid us to destroy such formidable machinery before it had opportunity to work further mischief.

This brings us at once to the point—the question of heredity. Are children not absolutely certain, but at least very likely, to resemble their parents, grand-parents, and more remote ancestors, not merely in complexion, figure, or stature, but in habits, in intelligence, in disposition, in force of will, and in all that is generally summed up under the word character? The doctrine is unpopular, since it has the misfortune to come into collision not with facts, not with established truths, but—what is perhaps worse—with dogmas. Two most antagonistic schools of thought fear that should the principle of heredity be formally recognised their systems will stand in need of revision. On the one hand, we encounter the radical or revolutionary sect of world-betterers, political and social, who not unnaturally see that if heredity is a fact, human equality—a main point of their creed—must be greatly limited, and that aristocracies have an existence founded in the nature of man. On the other hand, many theological and ethical authorities of great ability and weight consider heredity scarcely compatible with the doctrine of personal responsibility. If a man is born a murderer, how, they ask, can he be justly punished for murder?

We will first address ourselves to this latter class of objectors, as being apparently the more sincere and the more candid. They seem to consider that morally, if not intellectually and physically, every man is born alike. They do not, of course, deny the glaring, palpable fact that crime has run in certain families, but they contend that this result is due not to any transmitted innate peculiarities, but rather to evil example and bad training. These views are forcibly expressed by Dr. J. Mortimer Granville, in a paper on the "Physical Theory of Sin," recently published in "Good Words." None of the advocates of heredity, of course, are likely to deny that example and training in early life and companionship in later years are real and potent factors in the formation of character. Nor can it be questioned that the children of professional criminals are placed under very unfavourable circumstances. If not systematically misled, they are left to their own guidance, and to the contaminating influences around them. Still these post-natal circumstances are, we hold, far from explaining the whole of the case. Instances may be found where children of a criminal strain have been withdrawn from their parents at too early an age to have been corrupted either by bad precept or worse example, have been placed in virtuous society, and surrounded by the best moral influences; yet as they reached maturity their inborn criminal tendencies were manifested on the earliest opportunity. The writer may here be permitted to bring forward a case which happened within the scope of his personal observation, and for which he is prepared to vouch:—G. J. C., a young man of good family, was not certainly a criminal, but was what is known in America as a *loafer*. He was thoroughly idle, shiftless, intemperate, and profligate when he had money at command, and at other times ready to sponge upon his friends. Unfortunately he prevailed upon a young lady, ignorant of his character and position, to become his wife. After a short and unhappy married life he left her, went to Canada, and died there. The lady thus forsaken brought up her two sons—the elder of whom was not three years and the younger about ten months of age at the time of their father's departure—most carefully. That his example or conversation could have had any effect upon them is impossible. All influences for good which could be brought to bear upon them, at home, at school, and at church, were perseveringly applied. The younger, however, grew up to be the image of his father, in character as in person. If the doubters of heredity would watch with sufficient care, they could not fail to detect the transmission from father to son of traits of character, whims, and caprices incapable of being taught, and little likely to be adopted from imitation. And if dispositions are thus inherited in their minutest peculiarities, are the bolder and more decided features likely to escape reproduction? But why should theologians and moralists fear that if we admit the inheritance of character it will no longer be possible to maintain responsibility? As regards human laws this is altogether a delusion. Suppose a murderer pleads, as an apology for or extenuation of his deed, that he is sprung from a criminal stock, and cannot help taking life. Even admitting this helplessness—which after all by no means follows—Society may reply that this proves only the more convincingly the necessity for his elimination.

Nor can heredity be pronounced incompatible with man's responsibility before God. Does it not, after all, include the theological dogma of Original Sin, which divines have always been able to reconcile with responsibility? Nay, is not the inheritance of evil tendencies formally recognised in the words "visiting the sins of the fathers upon the children unto the third and fourth generation"?

Turn we now to the revolutionary opponents of Heredity, the followers of Helvetius, who consider that if a man is only caught young, duly Board-schooled, and afterwards examined by the Art and Science Department, he can be converted into a genius, an "advanced" thinker, or a cosmopolitan philanthropist, quite as easily as china clay and sizing can be transformed into good cotton cloth. Concerning responsibility to God or to man the writers of this school are not anxious. Nor, if we mistake them not, do they confine their denial of heredity to the moral aspect of man's nature. Of their manner of argument the following may serve as a typical specimen:—"Of all vulgar modes of escaping from the consideration of the effect of social and moral influences on the human mind, the most vulgar is that of attributing the diversities of character and conduct to inherent natural differences."*

Such outbursts are of course vastly easier than the calm and exhaustive collection and appreciation of facts bearing on the question of heredity. But letting this pass, we may ask if external influences, moral or social, can modify the conduct and character of the individual, what is our right to assume—as the author just quoted evidently does—that their effects must cease with his death, and fail to reach his posterity? Everyone has seen a series of parallel portraits entitled "The Child; what will he become?" Can we suppose that the diverse agencies which have moulded the one into intelligence, refinement, and integrity, but have warped the other into ignorance, vice, and brutality, will leave their descendants equal and similar, the minds of both groups being *tabulæ rasæ* as easily open to good as to bad impressions? Unless we can grant this monstrous postulate we must, "vulgar" as it may seem, recognise heredity as an important factor in the generation of conduct and character.

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* John Stuart Mill. Political Economy, vol. i., p. 390.

In meeting the deniers of heredity we are, however, placed at a disadvantage, inasmuch as they have hitherto brought forward no definite and tangible arguments for its rejection, but have contented themselves with the easier task of vituperation, or of mourning over the possible consequences of its general recognition. Till they produce objections of a different stamp they may perhaps be safely ignored. One thing at least is certain, that if there be any truth in heredity it is a principle which cannot be rationally or safely ignored in the framing and enforcement of criminal law. Without at all denying that a normal man may, under circumstances of temptation, transgress against the property and even the persons of his neighbours, we must admit that on the theory of inheritance the criminal class must produce its like. The murderers, the burglars, the ruffians of our day, are the sons of similar characters who infested the country some thirty or forty years ago, and are in turn becoming the fathers of a new generation of evil-doers. Surely, then, a most important point in criminal jurisprudence is the arrest of this succession. Of what use is the occasional imprisonment and the ultimate execution of the habitual criminal if he is suffered to become a father? It is often said by the humanitarian school that in the treatment of crime we have tried severity and failed. To this argument our reply is easy:—Our severity, though in some cases excessive, was illogical, as bearing no proportion to the moral delinquency of the offender. It treated crimes against property more rigorously than those against the person, and hence it failed to eliminate the most dangerous class of offenders, and it totally overlooked the propagation of a criminal type of population. It delivered over to the hangman a poor woman whose husband had been carried off by a pressgang, and who had stolen a loaf to feed her famishing children ; but it left the sons of the highwayman and the burglar free from all *surveillance*, and could see in them nothing different from its most orderly and virtuous citizens.

Fortunately a great European nation has shown us how, by a consistent course of severity, steadily carried out, any given class of a community may be stamped out. No one can fail to be struck with the utter lack of mental eminence among the Spanish people during the present century. Neither in the practical nor in the theoretical sphere have they reached anything beyond mediocrity. If we turn to the history of discovery and invention, the development of the sciences, and their applications in industry, Spain finds there no place. She is eclipsed even by Denmark and Switzerland, whose joint populations do not reach the fourth of hers, but who out of such small numbers have produced men with whom she has nothing to compare. It is the same in speculative philosophy and imaginative literature, the same in statesmanship and in war. The reason of this is not far to seek. It cannot be traced to any original want of vigour and energy in the national character. There was a time when no people on earth could surpass the Spaniards in these attributes. Nor is it, as some foolishly urge, to be traced to the enervating influence of the treasures obtained from Mexico and Peru. Britain, America, and Russia, we see, have not been enfeebled in energy and intelligence in consequence of the gold discovered in Australia, California, or the Ural. The true cause is this—that for more than two successive centuries the Spanish nation was subjected to a most careful and systematic process of "selection"—we can scarcely call it "natural"—by the Holy Inquisition. Every man who towered above his fellows, either by force of character, mental grasp, or by an enquiring disposition, became an object of dislike, and sooner or later was disposed of by death, by incarceration, or by banishment. The search after anything new was substantially interdicted. Those only were safe who, beyond satisfying the animal wants of their system, went duly to mass and to the bull-fight, and in all things else took the world easily. The consequence has been the condition of Spain such as we now perceive. This consideration is exceedingly significant. It is a most powerful evidence of the heredity of talent and of force of character. It may well be concluded, hence, that if, by a systematic and persevering course of action, ability, with its culminating point genius, has been stamped out among one great nation, so, by another course of action equally systematic and equally persevering, roughdom, with its culminating point crime, might be eliminated quite as thoroughly in another. It must not be forgotten that when in the good old times the Holy Office had roasted any man in the market-place, *ad majorem Dei gloriam*, it failed not to keep an especially minute watch upon the doings of his family, whether in the ascending, descending, or collateral lines. Here then it appears was a tacit admission of the heredity of character.

A still more striking recognition of the same principle is to be found in the annals of Oriental despotism. It was nothing unusual for sultan, shah, caliph, or mogul, when condemning to death any man who from points of view then prevailing was deemed an arch-criminal, to include in the sentence all his kindred. That here the mark was grossly overleapt needs little showing. All the children and other relatives, even of a Peace, are no more necessarily criminals than are all the descendants of a blood horse necessarily fit to be entered for the Derby or the St. Leger. But what the criminal legislation of the future will do—unless it be dominated by those who pander to crime—is probably this: the lineage and connections of every offender, and especially of every habitual criminal, will be carefully scrutinised, and all surviving members will be subjected to an unobtrusive but penetrating scrutiny. The younger members of the race will be as far as possible surrounded with such moral and religious influences as may most effectually check and counteract their probable inbred tendency to crime. They will be treated, *mutatis mutandis*, on the same principle as we now observe in handling petroleum spirit, nitro-glycerin, and other specially dangerous substances. Just as we guard the latter from the approach of fire, and prevent them from being accumulated in too great quantities at one place, so will the scions of a criminal family be kept from the contact of incitements to evil. Our courts of justice will have their criminal genealogists, whose records will shed a new and most valuable light on not a few unsolved problems, both of biology and of mental science.

As for the man who has once formally declared war against Society, hoisting, so to speak, the black flag, care will be taken that he shall neither repeat his offence nor after its commission become a parent.

One of the peculiarities of the half-educated public is that its attention is always rivetted on what happened last. To it the last antecedent seems the cause of any event; the arguments of the last speaker or author on any question appear the most convincing. In like manner it pities the just sufferings of the "poor" criminal, and totally forgets his victim. We are sometimes told that a very "humane jurist" expressed the opinion that the worst possible use to which a man could be put was to hang him. We demur to this view altogether. The worst use to which a criminal can be put is to let him loose upon Society, and they who urge such spurious mildness are in truth monsters of cruelty.

II. AMERICAN NERVOUSNESS: ITS PHILOSOPHY AND TREATMENT.*

By George M. Beard, M.D., New York.

AMERICAN nervousness, during the past half century, has expressed itself by a large variety of symptoms, a number of which are so frequent, so positive in their character, and so important that they have given names to disease, and are known as such. Among these symptoms and expressions of modern nervousness are neuralgia, sick headache, nervous dyspepsia, hay fever, and, above all, *neurasthenia*, or nervous exhaustion in all its various forms. These conditions, with others that might be mentioned, constitute a family of nervous diseases that have developed chiefly during the last half century,—at least, during the present nineteenth century,—and are most abundant, and most severe and most varied in their manifestations, in the northern portion of the United States, although they are found in, and are now extending to, England and the Continent of Europe.

The rise of this family of functional nervous diseases brings a new era into medicine and sociology, for it has no precedent in the history of mankind. The ancients had no nervous disease, or almost none, save a few cases of insanity and epilepsy here and there; and our moderns knew little or nothing about them until the present century.

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* Abstract of an Address delivered before the Baltimore Medical and Surgical Society.

The scientific proofs of this unprecedented nervousness of the Americans during this generation are very numerous.

First of all, there is the *increased sensitiveness to cold and heat* which is observed among all our brain-working classes. Our fathers were content with a temperature of 60° F. We must have, to be comfortable, a temperature of at least 70°; and there are many families who keep their rooms at even a much higher temperature. In other words, we are 10 degrees more sensitive to cold than were our fathers. The heat of our summers is no greater than it was a century ago, but the cases of sunstroke and heat prostration are widely out of proportion to the increase in our population.

One of the very best signs of our civilisation is found in the *premature decay of our teeth*. Special explanations without number have been offered for this long-observed phenomenon—such as the use of sweets, the use of acids, neglect of cleanliness, and the use of food that requires little mastication. But they who urge these special facts to account for the decay of teeth of our civilisation would, by proper inquiry, learn that the savages and negroes, and semi-barbarians everywhere, in many cases use sweets far more than we, and never clean their mouths, and never suffer, except in old age, from cavities in the teeth. The cause of the decay of teeth is subjective far more than objective, in the constitution of the modern civilised man. Similarly, also, with regard to irregularities of the teeth, which, as is now known, are dependent on bad nutrition of the jaws.

Delicacy of digestion is one of the best known and first observed effects of civilisation upon the nervous system. In all the great cities of the East, among the brain-working classes of our large cities everywhere, pork in all its varieties and preparations has taken a subordinate place among the meats upon our tables, for the reason that the stomach of the brain-worker cannot digest it. Three times a day, and every day in the year almost, pork in some form was the only dependence of our fathers in the last generation, who could eat it freely without ever asking themselves whether it was easy or hard to be digested.

The *eyes*, also, are good barometers of our nervous civilisation. The increase of æsthenopia and shortsightedness, and, in general, of the functional disorders of the eye, are demonstrated facts, and are most instructive. The great skill and great number of our oculists are constant proof and suggestions of the nervousness of our age.

It is demonstrable that nervous diseases have increased in recent periods; and that, with this increase of nervous symptoms, there has been also an increase in the æsthenic forms of disease, and a decrease in the sthenic forms; and, correspondingly, that there has been a change in the methods of treatment of diseases; that neurasthenia—nervous susceptibility—has affected all or nearly all diseases, so that nearly all illnesses occurring among the better class of people—the brain-workers—require a different kind of treatment from that which our fathers employed for the same diseases.

The four ways by which we determine these facts are—*first*, by studying the literature of medicine of the past centuries; *secondly*, by conversation with very old and experienced practitioners—men between the ages of seventy and ninety—who link the past with the present generation, and remember their own personal experience and the practice of medicine as it was fifty years ago; *thirdly*, from our own individual experience and observation; *fourthly*, by studying the habits and diseases of savages and barbarians of all climes and ages, and of the lower orders about us.

Statistics on this subject are of very little value, for reasons that will be clear to those who are used to statistics, and who know how they can be handled. Longevity has increased almost *pari passu* with this increase of nervousness and change in type of disease, and this has been a stone of stumbling and rock of offence to those who have discussed this subject. Both facts are true; longevity has increased among the brain-working classes, and nervousness has also increased. These two apparently opposite facts are harmonised by a third factor which those who have studied this subject have failed to reach—namely, nervousness is not only consistent with longevity, but actually favours it, by preserving the system from attacks of acute inflammatory disease. We do not bear blood-letting now as our fathers did, for the same reasons that we do not bear alcohol, tobacco, coffee, opium, and physical pain as they could. The change in the treatment of disease is a necessary result of the change in the modern constitution. The old-fashioned constitution yet survives in numbers of people, and in such cases the old treatment is oftentimes better than the modern treatment.

In the study of this subject I have compared a very large number of books of travel, and I have arrived at this fact, in regard to which there can be no doubt whatever, namely, that nervous disease scarcely exists among savages or barbarians, or semi-barbarians, or partially civilised people. Likewise, in the lower orders in our great cities, and among the peasantry in the rural districts, muscle-workers, as distinguished from brain-workers,—those who represent the habits and mode of life and diseases of our ancestors of the last century,—nervous diseases, except those of an inflammatory or syphilitic character, are about as rare as they were among all classes during the last century. These people frequently need more violent and severe purging, more blood-letting, more frequent blistering than the higher orders would endure.

What, now, are the causes of this increase of nervousness in America during the past half century? The primary cause is unquestionably civilisation, especially with its recent accompaniments, as the telegraph, railway, and the periodical press. These three institutions have drawn, and continue to draw each year, most severely on the nerves of nearly all classes, but particularly upon those who are favoured with education. The introduction and popularisation of the railway and the telegraph, and the development of the periodical press, belong, it will be observed, to the nineteenth century, and they have intensified in ten thousand ways cerebral activity and worry. This factor of civilisation applies to all the great countries—Europe as well as America.

But after we have given this cause every credit to which it is entitled, we are yet face to face with this question—Why are the Americans more nervous than any other people on this planet? The answer to this question, which has occupied the thoughts of philosophical observers for the past quarter of a century, is to be found mainly in these factors:—first, the dryness of our atmosphere; and secondly, the extremes of heat and cold. In these two respects America differs from any other civilised country.

Dryness of atmosphere produces nervousness in two ways: first, by taking up and absorbing the moisture of the body, thus causing us to literally dry up. When the atmosphere is moist, perspiration accumulates upon the surface of the body, because the air cannot take it up. Hence, in our dull dog-days, we are frequently annoyed by excessive perspiration. In a dry air which is hungry for moisture, the fluids of the body, as they become vapourised, are rapidly conducted away; the body is thus wasted of its fluids. Dry air also prevents the electricity of the body from being conducted away, and thus we become excessively charged with that force, and excessively stimulated by its confinement in the body. Moisture conducts electricity; and the moistened air insensibly carries away the electricity of the body, so that it is impossible for the body to become so excessively charged and stimulated. The evidences of this dryness of our atmosphere are numerous and striking. Clothes on the line dry more rapidly than in Europe. The specimens of the naturalists do not so quickly mould; the hair is stiffer and drier than that of our European contemporaries, and requires more pomade and oil. This peculiarity of our climate is observed from the Atlantic to California; and the Rocky Mountain region is far more under the influence of this dryness of atmosphere than even the East. The violent extremes of heat and cold—the bitterness of our winters contrasted with the heat of our summers—excite nervousness by over-stimulation. The application of latent heat and cold, as ice in hot water, is one of the most powerful means of local stimulation that we have in medicine: to this treatment nearly all of the American people in the northern and eastern sections are constantly subjected. Secondly, extreme heat and cold produce nervousness by compelling us to live in-doors in unnaturally dry and overheated atmospheres, and making it impossible, either in summer or winter, to partake of those active out-door exercises and amusements in which our English friends indulge at nearly all seasons of the year. The English climate, as contrasted with the American, is more equable. Its moisture, and even its unpleasantness and disadvantageousness, is favourable to the nervous system; likewise, the climate of our Southern States is more moist and more uniform than of the North and West; and, according to investigations that are variously made, nervous diseases of all kinds, or nearly all kinds, pretty steadily diminish in frequency as we go South.

The institutions of civilisation common to all enlightened countries—such as schools, newspapers, excitement of elections, reforms, and revivals—are themselves the results of climate and race, and are also to be included among causes of nervousness. Civilisation is burdened with information that it must acquire; every year history raises up new facts that the schoolboy of the future must commit and recite. If we would know why the Americans are so nervous, we should contrast the Greek boy with the New York boy in their manner of training in the schools, in their play, and in the whole order of their lives. The Greek boy's life was a poem, a constant holiday, a perpetual picnic. Of study, toil, or work, to which the New York boy is early trained, he knew nothing. Work is really a modern institution. All culture, history, science, literature, and languages that have appeared in the world during the past two thousand years, the lad of to-day must try to acquaint himself with. Of all these the Athenians knew nothing—could not even predict. When we contrast the life of an American child, from its early school days until the hour it leaves the university or seminary, the many and tiresome hours of study, the endless committing and repeating and forgetting, the confinement in constrained positions, the over-heated and over-dried atmosphere, the newspapers and novels that he is and must be prepared to converse about and criticise, the sermons and lectures which he is compelled to listen to and analyse, the strife and struggle for bread and competence against inordinate competition, the worry and concentration of work made both possible and necessary by the railway, mail-service, and the telegraph ; in view of these facts we wonder not that the Americans are so nervous, but rather wonder at the power of adaptation of the human frame for unfavourable environment. The education of the Athenian boy consisted in play, and games, and songs, and repetitions of poems, and physical feats in the open air. His life was a long vacation, in which, as a rule, he rarely toiled as hard as the American lad in the intervals of his studies.

The rapidity of our modern and American life has a tendency to concentrate an enormous amount of activity in a brief space of time. The intensity, the fierceness, and violence of our toil are the results of our climate, and in their turn they deepen and intensify our nervous sensibility. In the study of this subject the disposition has been to look exclusively at some one of these secondary elements—our haste in motion or our haste in eating, and to consider some one such factor as the sole cause of American nervousness. Indeed I may say that up to the present time this has been the popular mode of interpreting the unparalleled phenomena connected with American nervousness. Effects have, indeed, been confounded with causes—a process of reasoning which, it may be added, vitiates and destroys nearly all human philosophy, and nearly on all themes, but especially on questions of sociology, such as the effects of stimulants and narcotics, or diet, or social customs. American nervousness is a complex resultant of a number of factors—not a single result of one. In order to understand it, to grasp it, to master its philosophy, we must be able to see these factors all at once by themselves, and in their relations to each other.

There is one disease, the type and centre of a large family of functional diseases, to which I have applied the term *neurasthenia*. If we understand the philosophy of this disease and its treatment, there will be little difficulty in understanding the philosophy and treatment of very many of the family of functional nervous diseases to which it belongs. Neurasthenia is pre-eminently an American disease. It might, indeed, be properly called *Neurasthenia Americana*. Although it is found in England and on the Continent, it was here first systematically described, and here it exists in greater variety and frequency than in all other countries combined. The generic term neurasthenia—nervous exhaustion—I subdivide into two: cerebrasthenia—exhaustion of the brain; myelasthenia—exhaustion of the spinal cord.

Among the symptoms that I have referred to *cerebrasthenia* (brain exhaustion) are tenderness of the scalp, cerebral irritation, tenderness and whiteness of the teeth and gums, flushing of the face, special idiosyncrasies in regard to food and external irritants, morbid desire for stimulants and narcotics, insomnia in its varied manifestations, dilated pupils, melancholia or mental depression, deficient memory, or power of intellectual control, different forms of morbid fear, as astrophobia (fear of lightning), agoraphobia (fear of places), anthropophobia (fear of man and society), and its opposite, monophobia (fear of solitude), sick headache, and various forms of headache, and pains in the head, disturbances of the nerves of special sense, as *tinnitus aurium*, and specks before the eyes, subjective tastes and odours, dryness of the skin, eyes, throat, and mucous membranes generally.

Neurasthenia is differentiated from organic disease, by taking into consideration these four elements: (1) The fluctuations and inconstancy of the symptoms; (2) heightened reflex action; (3) the existence of some certain special symptoms, which will really be found in organic spinal disease; such, for example, as different forms of morbid fears, palmar hyperidrosis, excessive tenderness of the spinal cord, deficient thirst, abnormally active pupils, mental depression, extreme insomnia, morbid desire for stimulants and narcotics. In certain organic diseases, it is true, there may be heightened reflex action; but, as a rule, reflex action is diminished in organic or structural disease of the spinal cord. Closely analysed, a large proportion of the symptoms of neurasthenia, as I have before described them, are of a reflex character coming from the stomach, or some part of the genital apparatus, or, if they are not reflex in their origin, are at least made worse by a reflex irritation. To know this fact, and to act upon it in the treatment of these cases, is indispensable for success. One may treat sweating hands and flushing face and various neuralgias and headache indifferently without any permanent effect, until we attack and destroy the cause; (4) those in whom the nervous diathesis predominates are likely to have functional nervous disease.

In regard to the prognosis in cases of this kind, this general statement is sustained by experience, viz.: All of these cases can be relieved; many of them can be absolutely or approximately cured; but in all cases time and patience are necessary to bring about these results. I have watched these cases for years after they have left off treatment, and I keep up correspondence with patients who have been under my care, and thus have an opportunity to know what the issue is. Patients of this kind live to a good old age—may attain even unusual longevity, and may have their best health during the latter part of their lives. In regard to the details of treatment, I will state but a few facts.

First comes *electricity* in its various modes of application—central, general, and local. In the dosage, we are, in recent years, learning these four facts: 1. That it is sometimes best to use it in exceedingly small doses, mild currents and short applications. 2. That it is sometimes well to use a very strong and painful current. 3. That applications may be protracted for hours in succession. 4. That applications may be made much more frequently than is the general custom. These four propositions apply to nearly all our remedies. In truth, we are widening and deepening the system and range of our therapeutic forces by modifications of the quantity and quality and mode of administration. I have long taught that for spasmodic difficulties, like local sprains of muscles, convulsive tic, facial spasms, &c., very mild galvanic currents are preferable; but I have lately seen a case where very powerful and painful faradic currents, applied with the electric brush, or with the sponge, or both, and with as strong currents as could be borne, were more efficacious than the mild currents. Likewise in sciatica, and even other forms of neuralgia, painful currents that make a blister, or are at least very irritating to the skin, may succeed after mild applications have failed. An electro-puncture directly into the nerve itself will cure when the mild currents are powerless.

The ancients classed the divinities as major, minor—*Dii majores, Dii minores.* Similarly, neurotics may be divided into major and minor remedies. At the head of the major remedies—the *Jupiter omnipotence*—stands, without question, electricity; then comes ergot. That ergot contracts the blood-vessels, and thus is useful in local congestion of the brain and spinal cord, is one of the clearly established facts in physiology, and is one of the few definite, solid foundations for therapeutics; but that this effect on the blood-vessels is all that there is in ergot in its action on the body no philosophical student of nervous diseases would claim. Indeed, this contraction of the blood-vessels must be a result as well as a cause. Behind and beyond all this there is an influence which we cannot analyse. In some instances, very large quantities of ergotine may be given with benefit and without any harm that I can trace. I give ergot for immediate effects, for sick headaches, and for headaches of other kinds, and for long continued action in spermatorrhœa and various other conditions.

Another of these *Dii majores* of neuro-therapeutics is *arsenic* in its different forms. I use, not only Fowler's solution, but de Verlangan's, with also the English preparation of the chloro-phosphide. Arsenic is a remedy the effects of which are not, as a rule, felt at once. It needs to be kept up—to be persevered with for many weeks, oftentimes for many months. A well-known physician of New York was under my care for severe neurosis of the stomach, attended with vomiting of all of his food. Though he ate great quantities, he was growing thin and feeble, and he rebelled against nearly every treatment that had been suggested, or, at least, everything that I gave soon lost its effect. I urged him to use arsenic in small doses; at first he was somewhat averse to trying it, and had made up his mind to go to Europe. For a number of months I did not see him, and supposed he had gone to Europe. A short time since he came to my office and reported that he had tried the arsenic as I had recommended, and that the effect had been immediate, and, with but a slight relapse, up to that time permanent. He had gained in flesh, and regained his power to digest food. The remedy, indeed, acted with specific effect upon him.

Another remedy that perhaps will become, if it is not already, one of the major divinities of neurology, is *cannabis indica.* It is one of the drugs by the proper use of which the treatment of sick headache, for example, has been, within a few years, revolutionised, both for temporary relief at the beginning of an attack, and during the attack, and as a permanent cure, provided its action is maintained for weeks and months. Its quick and permanent influence over the symptoms of headache suggests its great value in other conditions allied to sick headache, or from which sick headache springs.

Another remedy, not very widely known, but one the value of which is easily proved, is *citrate of caffeine*, and allied to caffeine is *coca*, belonging, indeed, to the same family; indeed, it is the active principle of common coffee, tea, guarana, and chocolate. It relieves the pain and uneasiness that follow over-exertion, and the peculiar distress that comes from sleepless nights, for which purpose, I may say, caffeine may also be used.

The *zinc* preparations, particularly the bromide, valerianate, and oxide are sedatives of very great value in various neurasthenias, and I use them with great freedom. I gave once the zinc combination, including the bromide, the valerianate, the phosphide, and the oxide, to a physician who consulted me about a year ago for neurasthenia, resulting from over work in his profession. In a few weeks he reported himself to me to express his gratitude and to testify to the great value of the remedy as a hypnotic as well as a sedative.

Duboisia, the new remedy from Australia, is likely to take a minor if not a major place among the resources of the neurologist. Its effect is somewhat like that of atropine, but yet not entirely like it; and, for the symptom of hyperdrosis, seems to be more effective according to experiments that I have made with it.

Cimicifugin is a remedy the value of which in choreic condition is undeniable, and I am persuaded that its use need not be restricted to those conditions.

Strychnia is one of our older remedies, and I use it sometimes alone, but very frequently in combination with other remedies; yet it cannot be used in all cases, for sometimes it has a depressing effect.

Opium, in small doses, is excellent for many phases of neurasthenia; and were it not for the danger of forming the opium habit, I should use it more frequently than I do.

Alcohol also, in the form of wine, particularly claret and burgundy, is to be advised in some cases of this kind, but not recklessly, or without reference to the age, character, and temperament of the patient. Alcohol is one of the best of our hypnotics in cases where the bromides fail to produce sleep. Where chloral causes severe headache next morning, claret wine, freely used, may produce satisfactory effects without any unpleasant after effects. In the treatment of nervous cases, it is sometimes necessary to use all of these potent remedies in incredibly and absurdly small doses.

Dilute nitro-muriatic acid, either alone or combined with the vegetable bitters, I use in different forms of nervous exhaustion, especially where the urine is over loaded, as it often is, with oxalates and urates.

Of *cod-liver oil,* I may say that it probably does more for the nervous than it does for the consumptive. Oil and fats, like cream and butter, are brain food, and if used judiciously, as the stomach can bear them, act both as food and as medicine. The oil I use generally in the form of emulsion, and I use it with great freedom.

Of *phosphates,* this can be said: that they belong to the list of over-praised and over-used remedies. All these stock remedies have a certain power which, in very many cases, they soon expend—they reach the limit of effect, beyond which they cannot be forced.

Another new remedy, or comparatively new to this country, is *koumiss*—fermented milk. The power of this remedy to produce sleep is very great, and very satisfactory. It is a means of nourishing the body without disturbing or even using the stomach to any very great degree. Koumiss is really digested milk, and is absorbed and taken up into the system without any strain upon the digestive apparatus. I am persuaded that the use of koumiss in the future is to be very widely extended for all conditions where nutrition is difficult—not only in adults, but in children. The one disadvantage of koumiss in some cases—that it constipates the bowels—is to be met by laxatives.

Another very old remedy, but as good as it is old, where it is properly used, is counter-irritation, which I employ both in the form of *actual cautery*, and galvanic cautery, and very small blisters, so small and so arranged as to cause very little annoyance. Counter-irritation in the hands of those who really understand how to use it without abusing it, is one of the three or four major remedies of neuro-therapeutics. The actual cautery, as it can be used, and is used by those who understand it, is not specially painful, even to the most delicate woman. The pain is in the idea of the thing—in the expectation, and not in the burning. I speak of this point particularly, because the cautery is an agent of such great therapeutical power. This mode of treatment, like the blisters already referred to, must be, and now can be, modified and adapted to the sensitive modern constitution.

Hydro-therapeutics in the form of bags of hot and cold water, the Russian and Turkish baths, and alternate applications of hot and cold is, in skilful and judicious hands, a great remedy for functional nervous diseases.

It is impossible to speak of the treatment of this class of troubles without referring to the *bromides* of potassium and sodium, and lime and lithium. Bromides may now be classed among the old remedies. Their great value in epilepsy has long been known. They are not, however, so well understood in other nervous diseases of a functional character. The bromides may be used in large doses, frequently repeated until the powerful sedative effect is produced, even when there is no sleeplessness; those who use the bromides in this way must know where to stop or to reduce the dose.

There are a few general principles of treatment of which I will speak. First of all, the proper use of *rest* and *work* in the treatment of nervous disease. About a month ago, a patient with ataxy came to me from a distant city in the West; I said to him, "you have left behind you a better doctor than you can find here." He asked, "Who?" I said "*rest!*" I prescribed it for him, and put him to bed. He had been accustomed to take excessive exercise—at least, far more than was good. The next day another gentleman came, also from a distant city of the West, with the history of a certain form of cerebrasthenia—brain exhaustion—without any myelasthenia, or spinal exhaustion—and of a type that would be benefited rather than injured by a degree of mental and physical activity. He had felt disheartened and thought there was little for him to do in this world. He was of about middle life, and I told him that he probably was no more than "half-way home," and, so far as the disease was concerned, he might live and be active for thirty or forty years longer. When he returned, I said to him, "you have come a long distance to consult me, but you left at home a better physician than you can get here." He asked, "Who?" I said "*work;* work I prescribe for you. Take that in connection with all your medicine and you will recover." These two cases made clear the opposite methods of treatment.

A second and general suggestion is, that of a stopping treatment or suspending it at times. Suspending treatment has a positive effect upon the system. Oftentimes it makes a direct impression, which may be better than continuous treatment. A friend of mine, formerly a sea captain, states that when sleeping in his cabin at night, if the sentinel walking the deck above him stopped, it would always wake him. The sudden sensation of nervous activity, like a jar upon the nerves, aroused him from his slumber. I find that patients sometimes do better—make more decided progress—in these intervals of treatment than while the most active measures are being used. Patients sometimes imagine this a proof of the valuelessness of the medicines; but it is in reality a proof of their power. It has been said that success in life depends largely upon knowing just where to stop. In the practice of medicine, this maxim is certainly sound; and to know where to stop, to let up, to modify the treatment, is one of the best tests of medical skill.

The third general suggestion is, that in the treatment of nervous diseases, we should study with all our energy the psychology of our patients; we must make a diagnosis of the intellectual character as well as of the disease before we can make a prognosis or adopt a plan of treatment. There are those whose minds are so organised, which lack some qualities and have excesses of others—usually a preponderance of the emotional, with a deficiency of the higher intellectual qualities—that they act badly under any treatment, however wise. Some patients take a pleasure in their distresses; it would be cruel to cure them; their pains are their possessions. Any man wishing to make them well would be no better than a thief or a robber. There are those whose chief felicity in life consists in doctoring and being doctored, and to whom the removal of their bodily ills would be like the death of long cherished friends. When such persons come under your care, you cannot expect any treatment to be as successful as with those strong and active intellects, who understate rather than magnify their troubles, and are resolutely determined to get well.

III. MOVING ROCKS.

A REMARKABLE instance of rocks moving out of water on to dry land is recorded by the Earl of Dunraven in an article on "Moose-hunting in Canada," which which will be found in the July No. of "The Nineteenth Century." The attention of Lord Dunraven was directed to this phenomenon during a visit to Nova Scotia in the fall of last year, but only a day or two before he left the woods, so he had not time to make any investigation into the subject. A lake of considerable extent, but shallow, was full of great masses of rock. "Many of these masses," observes Lord Dunraven, "appear to have travelled right out of the lake, and are now high and dry, some 15 yards above the margin of the water. They have ploughed deep and regularly defined channels for themselves. You may see them of all sizes, from blocks of, say, roughly speaking, 6 or 8 feet in diameter, down to stones which a man could lift. Moreover, you find them in various stages of progress, some a hundred yards or more from shore and apparently just beginning to move; others half-way to their destination; and others again, as I have said, high and dry above the water. In all cases there is a distinct groove or furrow which the rock has clearly ploughed for itself. I noticed one particularly good specimen, an enormous block which lay some yards above high-water mark. The earth and stones were heaped up in front of it to a height of 3 or 4 feet. There was a deep furrow, the exact breadth of the block, leading down directly from it into the lake, and extending till it was hidden from my sight by the depth of the water. Loose stones and pebbles were piled up on each side of this groove in a regular clearly defined line. I thought at first that from some cause or other the smaller stones, pebbles, and sand had been dragged down from *above*, and consequently had piled themselves up in *front* of all the large rocks too heavy to be moved, and had left a vacant space or furrow behind the rocks. But if that had been the case the drift of moving material would of course have joined together again in the space of a few yards behind the fixed rocks. On the contrary, these grooves or furrows remained the same width throughout their entire length, and have, I think, undoubtedly been caused by the rock forcing its way up through the loose shingle and stones which compose the bed of the lake. What power has set these rocks in motion it is difficult to decide. The action of ice is the only thing that might explain it; but how ice could exert itself in that special manner, and why, if ice is the cause of it, it does not manifest that tendency in every lake in every part of the world, I do not pretend to comprehend."

IV. PETROLEUM AS A STEAM-MAKER.

THERE are said to be 7,000,000 barrels, of 40 gallons each, of crude petroleum now above ground in the oil regions. Every hour adds to this ocean of oil; in spite of the enormous consumption the stock accumulates. Every new use to which petroleum is applied possesses interest to producers, and the day that shall see crude oil take the place of coal as a steam-producer will be a glad day for mankind in general and oilmen in particular. That such a day is not very far distant seems evident after an inspection of the working, recently, of an oil-burning device tested on a river steamer at the Monongahela Wharf. The experiment is thus described in the " Pittsburg Telegraph:"—

The invention is the property of the American Hydrocarbon Gas Company (John Campbell, General Manager), and embraces simple but vital principles of construction, wherein atmospheric air and steam are combined in proper proportions with oil, and injected into the firebox beneath the boilers in the form of spray. The latter, being immediately converted into inflammable gas, becomes a pure, bright, powerful flame, devoid of smoke, and producing intense heat.

To accomplish this result extremely simple machinery is used. A small hole is drilled into the iron front of the firebox, and into this passes a tube which branches as it leaves this point into two pipes. One of these connects with the boiler itself, and the other with the receptacle containing crude oil. At the juncture of these pipes there is an aperture for the admission of outer or atmospheric air. Valves of peculiar construction regulate the quantity of steam or oil admitted to the furnace. This is all the machinery required, but its operation is wonderfully complete and remarkably successful.

The little steamer *Billy Collins* was selected by Mr. Campbell for the test, and was fired up at 9 a.m. A preliminary blaze of wood under the boiler raised the small quantity of steam necessary to start the burner into operation. The oil valve was opened a trifle, the steam valve ditto. The petroleum trickled into the feed-pipe, was caught up by the steam, and both plunged into the depths of the firebox, a mass of many-tongued, roaring, brilliant flame.

As the pressure of steam increased, this flame grew in fury and intense heat, roaring through the entire length of the boiler with a sound like the coming of a thunderstorm. The needle of the steam gauge climbed rapidly up the dial, and in twenty minutes the safety valve blew off at 120 lbs. pressure. It was a remarkable sight. Here was a boat puffing through the water with no sign of smoke from her chimneys, no speck of soot in flues or firebox, no fireman, no opening of furnace doors, no dirt, no coal going in, and no clinkers or ashes to be seen anywhere. A turn of the hand regulated the terrible flame that seemed trying to overpower the limits of the furnace, and another turn of the hand brought the fire down to a quiet little flame, a foot or two long. During the forenoon occupied by the test about 20 gallons of crude oil were consumed; and Mr. Campbell's estimate was, that with oil at one dollar per barrel this fuel was equivalent to coal at six cents in heat-producing value, other things being equal.

But other things are not equal by any means, and everything is in favour of oil as against coal. The labour and expense of "firing up" is dispensed with, and the engineer can regulate the flame as he does the steam in his engines. The danger from sparks and flying cinders is entirely done away with. The space occupied by oil, as compared to an equal value of coal, is very much less, and this much is gained for cargo. Further, the wear and tear upon boilers, grate bars, &c., is infinitely less, and, it seems scarcely necessary to add, the comfort of passengers is greatly enhanced by the absolute freedom from dirt of all kinds.—*Scientific American.*

V. THE MAY TORNADOES OF KANSAS AND MISSOURI.

By Prof. John D. Parker, Kansas City.

On May 30, 1879, occurred two of the most destructive tornadoes that were ever known to visit the Lower Missouri Valley. This statement is verified, whether we consider the violence of the tornadoes, the extent of territory passed over, the amount of property destroyed, the number of persons injured, or the loss of life.* These two tornadoes we have named from the towns where they did the most damage, and will treat them as follows:—

The Lee's Summit tornado seems to have originated near Belton, Cass county, Missouri. In the afternoon of May 30, 1879, there was a heavy shower at Belton, accompanied with hail, while further east another heavy storm was raging. Late in the afternoon these two storms seemed to unite to form the tornado, which passed off in a northeasterly direction. At Raymore, Cass county, several persons state that they saw the clouds gradually approach each other, forming two funnels in the air at the same time, which seemed to approach and play around each other, and then unite to form one mighty column, which swayed and rocked to and fro like a huge balloon, with the roaring and rushing of a thousand locomotives, as it passed on its way, levelling everything before it.

At Lee's Summit the people report the weather, on the afternoon of the 30th of May, as very sultry and oppressive, with a warm wind blowing from the south. Toward evening a cold current of air came down from the north-west, accompanied with hail and some rain. About six o'clock a black cloud from the south-west suddenly burst upon them, and the tornado swept by about two miles south of the town. A correspondent, who visited the path of the tornado, reports that everything in the shape of vegetable life was mowed clean, and the ground torn up in places, especially on hillsides, as if hundreds of men with shovels had dug it up for a road-bed of some giant railroad. The largest trees were twisted off close to the ground like pipe-stems, or taken up by the roots and carried for hundreds of yards, and then dashed to the ground and splintered, in some cases, as fine as kindling wood. Ponderous rocks were hurled from their beds hundreds of yards and broken into fragments. Buildings and fences were swept away, and timbers carried in some instances over a mile and driven endwise several feet into the hard earth. Animals are reported as having been taken up and carried some distance, and let down uninjured.

The people at Blue Springs, about twelve miles north-east of Lee's Summit, liken the tornado to a huge tower of inky blackness reaching to the sky, preceded by a fearful rushing and roaring noise, the mass of the ascending column being perfectly opaque. Passing south of Blue Springs nothing could withstand the violence of the tornado, the most substantial houses in the vicinity of that place being swept away in a moment. Numerous instances are given showing the violence of the storm. The mould-board of a plough was wrenched off and carried some distance; a new waggon was wrecked, the spokes being wrenched from the hubs, and the tires bent into a variety of fantastic shapes. Trees were stripped of their bark and looked as if scorched, which phenomena was first attributed to electricity, but afterwards found to be a discolouration by a peculiarity of the sap. Prostrated trees were found lying some at right angles to the path of the tornado, and some pointing toward the vortex. Evidences are abundant that the funnel of the tornado contained a large amount of *débris*, and mud having a sulphurous odour, which was dashed with tremendous force and plastered over every obstacle remaining in the path of the tornado. A fence near Blue Springs, running east and west, was thrown down, the west end toward the south, the east end toward the north, showing the direction of the currents. A short distance beyond Blue Springs the tornado seemed to be lifted from the earth, not doing any more damage.

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* I take pleasure in acknowledging my obligations to various persons for assistance furnished in reference to the May tornadoes, especially to Dr. F. A. Ballard and Mr. Charles H. Clark, of Independence, Missouri, and to Dr. Isaac B. Smith, of Frankfort, Kansas, and also to Miss Kate Slosson, a pupil of Mrs. Clara Hoffman, Principal of the Lathrop School, Kansas City.

A correspondent, going from Blue Springs to Lee's Summit, says that for several miles the road runs along almost parallel with the track of the tornado, which was nowhere more than three hundred yards in width, and in some places was contracted to fifty yards. Some persons escaped who were caught in the tornado, although instantly blinded, stunned, and covered with mud, and carried they knew not whither. The path of the tornado was deflected a little, about three miles south-west of Blue Springs. It seemed to sweep over hills and ridges and through ravines alike, carrying everything before it. It is impossible to give the mass of particulars gathered for this article, and many reports must be taken *cum grano salis*. Some four persons were reported killed, and a large number injured, some perhaps fatally. A correspondent traced the track of this tornado, giving range for the path examined of nine miles east and twenty-one miles north. The tornado passed along an elevated portion of the country, or a divide, the heads of streams along its course flowing from it both east and west. One of the U.S. Signal Corps observers, I learn, traced the path of this tornado back nearly to Paola, in Kansas.

The Irving tornado had its origin probably as far west as Ellsworth county, Kansas, and crossed the Saline river at the mouth of Twelve-Mile Creek, where it did its first damage. It travelled in a north-east direction, through Lincoln, Ottawa, Clay, Riley, Marshall, Nemaha, and Brown counties, and passed into Richardson county, Nebraska. The same general storm touched Cawker City and Beloit, Mitchell county, Kansas, at about 2.30 p.m., unroofing at the latter place the tent of a circus which was in full blast, blowing down a number of houses, and twisting large trees in pieces as it passed down the Solomon river; this storm being, perhaps, an outlier or feeder of the main tornado. The Irving tornado passed about four miles south of Delphos, which has since been almost destroyed by another tornado, June 9, 1879.

After passing the Solomon river, the Irving tornado seemed to increase in violence and destructiveness. Some describe its appearance in its approach as "cloudy pillars" resembling smoke, afterward assuming an inky blackness, all rolling, dashing, and clashing with each other, as if engaged in a furious battle. The tornado struck Stockdale, Riley county, doing some damage, whence it passed on, crossing the Blue river, lifting all the water out of the bed of the stream, and scooping the water, it is said, out of a well.

The people at Irving saw, just before 5 p.m., a dark mass of clouds gathering south-east of the town. A deep roar was heard, when the clouds began to lower and spin like a top, advancing upon the town and destroying one small house in the outskirts. This seemed to be a prelude, followed by a calm. Suddenly the heavens turned a greenish hue, and, with an awful roar, the tornado burst upon them, leaving the southern portion of the town a mass of ruins.

The tornado then swept onward, with a path from one-half to three-fourths of a mile in width, and when within two miles of Frankfort it passed up the west fork of the Vermillion river, in a north and north-east direction, a distance of fifteen miles, near Axtell, where it turned again upon its normal path and passed on near Sabetha, and into Richardson county, Nebraska. About fifty houses were blown down in the vicinity of Frankfort, and fifty families left destitute.

During the passage of the tornado neighbouring towns received more or less damage. Vermillion suffered slightly, some of the houses being started from their foundations.

Centralia, Blue Rapids, and Waterville received some damage.

I give some singular incidents of the tornado, as related on good authority:—

Mr. Fitch's son was blown across a ravine, over trees and fences, and landed unhurt on the door-step of a house half-a-mile distant. When asked how he came there, he replied, "I do not know!" Mr. Yawger found one of the wheels of his waggon 2½ miles from home. A tire was blown off a waggon wheel and straightened out as well as a blacksmith could do it. The body of a lady was driven into the ground head foremost, covering head and shoulders. A coat was torn from one man, divided in the centre, the halves being driven in opposite directions. Some of the fowls were picked clean of their feathers. On Snipe Creek, large elm, oak, walnut, cottonwood, and sycamore trees were twisted off and torn up by the roots, leaving a fine forest a scene of desolation.

The number of killed and injured have been variously estimated. At Irving and vicinity, thirteen were killed and fifty wounded. At Frankfort and vicinity, five were killed and forty injured. At Delphos and other places large numbers are reported killed and injured. The people along the route of the tornado were engaged in little else for several days but in burying the dead and caring for the wounded.* In Marshall county alone the damage to property and crops is estimated at 150,000 dollars.

On May 29, 1879, occurred a destructive tornado in Andrew and Nodaway counties, Missouri. A correspondent says, on that calendar day, at Bolckow, Andrew county, a hot wind blew from the north-west for several hours. The skies had been overcast from early morning with clouds, which frayed off and separated into light-coloured masses and drifted away, and finally dissolved in the atmosphere. About three o'clock clouds banked in the west and north-west in heavy black masses, and a current of hot air from the south-west appeared to hurl them in wild wreaths like battle clouds on one another. About four o'clock the citizens were startled by seeing a wild funnel-shaped cloud appear in the west, and sweep onward as if to doom their town to destruction. Its muffled thunder-roar was soon distinctly heard, and immediately it swept by the town upon its destructive mission. The track of the tornado lay about three miles north-west of the town, and presented the looped and ragged edge, so often seen in tornadoes, on the south side. Observers say the tornado at times seemed to stop and take a backward turn, and then sweep on with renewed force. In this manner the tornado would destroy alternate pieces of property, leaving, perhaps, a house standing in the loop unscathed. The tornado passed about a mile north of Barnard, Nodaway county, and, when last observed, was moving toward Conception, Nodaway county. The violence of the tornado was very great; large trees, two and three feet in diameter, were twisted off, and the most substantial houses were lifted into the air and dashed in pieces. In one place it swept through a ravine, lifting out of its narrow walls every stick of timber, so that the bed of the ravine seemed to have been swept with fire. The northward tendency of this tornado in translation was probably due to surface currents.

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* Immediately after the occurrence of the Irving tornado, Governor St. John issued a proclamation calling on the people of Kansas to render assistance to the sufferers, heading the subscription himself with a liberal contribution, and all has been done that is possible to relieve the sufferers.

Samuel W. Rhode, U.S.A., Sergeant of the Signal Corps, of Leavenworth, has kindly furnished notes, from the journal of that station, on the storm of the 29th of May, which are as follows:—

"This evening one of the most severe storms that has visited this section for several years past passed over this station. During the afternoon the sky was partially, and sometimes fully, covered with heavy, cumulus-stratus cloud, moving rapidly from the south-west. The wind was blowing briskly from the south, with a low and steadily falling barometer and rising temperature. At 5 p.m. a heavy dark mass of 'thunder heads' appeared on the north-west horizon, and gradually moved eastward, increasing in bulk and extending toward the zenith. Frequently, during the formation and development of the storm cloud, as many as four different currents in the air were indicated by the movement of the clouds. The 'cyclone,' or spiral, motion of the wind was plainly discernible in the clouds for over an hour before the force of the storm was felt at the surface. Rain could be seen falling to the north of the station for ten minutes before there was any precipitation here. It looked like vast and dense volumes of fog impelled eastward at a high velocity. At 6.35 p.m. a few scattering drops of rain began to fall. At that time the heaviest portion of the cloud was directly north of the station, the apex being about 60° above the horizon, the wind blowing in fitful gusts from the south. At 6.58 p.m. the barometer reached its lowest point, the actual reading (corrected for temperature and instrumental error only) being 28·670. At 7 p.m. the wind suddenly backed from south to north and increased in force, blowing for about five minutes at the rate of 60 miles per hour. The cloud then moved rapidly southward, trending toward the east. The rain fell in perfect torrents for near an hour. From 7.10 to 7.40 p.m. considerable hail fell: a number of stones were measured and averaged from ¼ to ⅜ of an inch in diameter. The electrical discharges were very intense and almost constant. The force of the storm expended itself about 8.5 p.m. The rain ceased at 8.15 p.m., and the amount which fell in one hour and forty minutes was one inch and forty-three one-hundredths.

"The storm produced no serious damage in this city or vicinity. A large number of trees in the city were blown down, and several large buildings suffered damage by lifting of roofs. Fruit trees and growing grain were somewhat damaged by the hail. The position of fallen trees, in different portions of the city, plainly indicated the spiral motion of the wind. The large iron bridge over the Missouri river at this point, on which was a train of heavily laden cars, swayed so much that the engineer jumped from his engine, thinking the bridge was toppling over.

"At about the same hour, a very destructive tornado struck the earth north of this station, near St. Joseph, Missouri. No doubt the disturbance felt here was an offshoot of the above mentioned tornado.

"During the evening, from 9 to 11 p.m., the electrical display in the south, south-east, and east was very beautiful and vivid. The heavens were almost continually illuminated. Frequently there were seen as high as a dozen streaks of lightning, of the *zig-zag* form, which seemed to radiate from a common centre."

Several theories have been advanced in reference to the causes of tornadoes. In the present article I have only space to discuss one of them.

Storms are supposed to find their origin, according to the Thermal theory, in an unstable equilibrium of the atmosphere due to solar heat. About three-fourths of the sun's rays pass through the atmosphere, and are absorbed by the surface of the earth. The envelope of the earth is thus heated mainly at the bottom, while it loses most of its heat by radiation at the top. As an increase of heat diminishes the density of the air, the envelope of the earth is in a constant state of unstable equilibrium. The upper and heavier strata of the atmosphere tend constantly to descend and force up the lower strata. Vertical currents are thus formed over greater or less areas of the earth's surface by solar heat every day. The vapour contained in the air is thus carried up by the ascending current until it is condensed into cloud by the expansion and cooling of the air which contains it. The latent heat of the vapour thus liberated tends to elevate the temperature of the air containing it, causing it to be lifted to still higher altitudes. The violence of this upward movement is largely due to the amount of vapour, or the "steam power of the air."

The centre, or core, of a storm sometimes becomes a tornado, which possesses a linear or gyratory movement. Connected with these there is a swaying movement, caused by obstacles, such as hills and forests, along the path of the storm, and sometimes the tornado seems to be drawn up into the air.

I have noticed quite a number of whirlwinds observing the laws of tornadoes. In 1872 I saw a beautiful whirlwind at Burlington, Kansas. While walking toward the town from the north-west, I heard a rushing sound southwest of me. Soon I saw the prairie grass swaying violently, and I had a perfect view of a miniature tornado, as it passed across the road a few rods ahead of me. The atmosphere was tranquil at the time. Here was a whirlwind ploughing its way through a tranquil atmosphere at the rate of ten miles an hour, moving east by twenty degrees north, and gyrating in a direction contrary to the hands of a watch.

Tornadoes in the northern hemisphere are translated toward the east by about twenty degrees north. Deflections from this direction are supposed to be occasioned by local causes, such as rivers, surface currents, &c. The Irving tornado was deflected from its path near Frankfort, passing up the west fork of the Vermillion river, in a north and north-east direction, a distance of fifteen miles, when it again resumed its normal path. North of the equator, tornadoes revolve in a direction contrary to the sun, or the hands of a watch with its face upward, while south of the equator they revolve in an opposite direction.

Tornadoes, according to this theory, originate in disturbing causes acting suddenly, but take their character from the cosmical conditions of the globe. The average temperature of the globe is about 85° at the equator, decreasing to about zero at the poles. This excess of heat expands the air in the equatorial regions, which flows over toward each pole. The larger portion of this circulation, however, is confined to a belt not extending beyond the thirtieth parallel of latitude, because the current is cooled in the upper regions, and the meridians narrow toward the poles.

As the atmosphere is carried around with the earth in its daily revolution, the greater the elevation the greater the velocity eastward. A stream descending from the upper regions of the atmosphere would be impelled by its inertia when it reached the earth in an eastward direction. As parallels of latitude decrease in diameter from the equator to the poles, every parallel, going from the equator, revolves with less velocity than the preceding one. Should a portion of the atmosphere become saturated and unduly heated at the surface of the earth, it would be forced up by colder and heavier air. Currents of air would be formed blowing toward a common centre. In the northern hemisphere those from the north would naturally find the centre moving eastward with a superior velocity, and, falling behind, be projected toward the west, while those from the south would find the centre moving eastward with an inferior velocity, and be projected toward the east. The north half of the tornado would be impelled westward, and the south half eastward, establishing the whirl or vortex, which is a low barometer. The currents descending into the vortex on the south side having a greater impulse eastward, from the earth's rotation, than the impulse of the currents westward descending on the north side, the tornado would be deflected toward the north-east. The liberation of the latent heat by the condensation of the vapour would be the "steam power of the air" to drive up the ascending current; large amounts of electricity would be developed for destructive purposes, and the tornado would sweep on its path to overwhelm towns, crush forests, lick up rivers, and make the solid earth tremble.

The Thermal theory only uses heat, under cosmical conditions, as the *motive* power, leaving much of the phenomena to be accounted for by electricity and other destructive agencies.

Modesty should cover all theories of these awful but occult visitors like a garment. A few golden threads are in our scientific fingers, but the theoretic fabric for tornadoes is still largely to be woven. Do not let us imitate that great German scholar, who in his mature years found the works of his earlier life the hardest to answer.

There need not be any special alarm about tornadoes. Like great comets, they seldom appear, but on that account are the more noticeable. Destructive tornadoes only occur during dry seasons, and then, in this latitude, only on the last few days of May or on the first few days of June. The greatest tornado on record occurred June 3, 1860, the year of the drought. It passed over a large portion of Iowa and

Illinois, destroying Camanche, and killing fifty persons. That would not be an unusual railroad accident or ocean disaster. We stand a hundred chances of being killed in ordinary travel to one chance of being killed by a tornado. Still, we take our sleeping berth and fall into a quiet slumber. Tornadoes also occur just before evening, and, if we remember the law of their movement, we can generally escape them. Although, then, we may never be killed by a tornado, still it is always well to keep a clear conscience.—*Kansas City Review of Science and Industry.*

VI. THE PIRATE'S SHEET-ANCHOR.

THE common-sense doctrine that the right of an inventor to the creations of his own mind is the most natural and sacred of all kinds of property, though substantially self-evident, is far from meeting universal acceptance. That our ancestors in their ignorance ranked copy-right and patent-right among "monopolies"—just as they classed the whale among fishes, and confounded astronomy with astrology—is an unfortunate circumstance, which cannot, it seems, be forgotten. In a political economist the very word brings on a state of fury bordering on madness. Call any institution, right, or possession a "monopoly," and he strives to destroy it without further question.

For the benefit of persons capable of judging soberly and righteously, it may be well to examine the ostensible grounds on which pirates rely when they proclaim patent-right not property, but a mere privilege.

Their first argument is one which it is simply astonishing, and even painful, to hear from any man of mature age and good education. It is in substance this, that as an invention is often sought after or aimed at, and sometimes even attained, by several persons simultaneously, it cannot, when completed, be considered the property of any person! That we may not be accused of unfairness I will use the very words of the piratical school, as given in the "Dictionary of Science, Literature, and Art," by W. T. Brande and Rev. G. W. Cox (article "Patents," vol. ii., p. 834). The article in question appears to be from the pen of Professor Thorold Rogers, though we have no right to assume that the views expounded are his own, since he introduces them with the words "It is alleged." We are there told that "simultaneous discovery is the rule, independent invention the rare exception; that, in fact, a patent is ordinarily assigned to the mere accident of priority, to the detriment of others who have as effectively found out the power or the process appropriated."

Mr. R. A. Macfie, in his recent work "Copyright and Patents for Inventions" (Preface, v. and vi.), writes—"An invention may be, and commonly is, originated by a plurality of persons in complete independence and ignorance one of another, and of what each other does or has done."

The present writer cannot for one moment admit the validity, or even the relevance, of this contention. The champions of piracy admit, as we see, that in a minority of cases, at any rate, an invention originates from a single individual exclusively, no other person having been searching or experimenting in the same direction. In such cases, then, the argument entirely fails, and the invention, for anything our opponents have yet advanced, must at once be classed as property.

But further, the assertion that "simultaneous discovery is the rule" must be termed a grave exaggeration, improbable on *a priori* grounds, and questionable as regards the evidence upon which it rests. If we consider what multitudes of known and admitted desiderata exist in addition to the vastly greater number of instances where the room for an invention exists unrecognised; if we reflect, moreover, that the solution of each such industrial problem, chemical or mechanical, may be attempted or even effected by a plurality of methods, we shall see that there is a great antecedent improbability in the notion of a number of independent inventors simultaneously originating the very same novelty. We are well aware that when a certain want or difficulty is felt, inventive minds will naturally turn their efforts in that direction. But as a rule, in as far as they are *bonâ fide* inventors, though in pursuit of the same object they will proceed by different ways. Of this truth the history of modern invention furnishes some striking instances. The beautiful dye known as "malachite green" has been obtained simultaneously, or nearly so, by two distinct chemists "in complete independence, and perhaps ignorance, one of another," and on superficial examination this case might seem to tell in favour of Mr. Macfie and his friends. But if we look more closely into the matter we shall see that Doebner, of Berlin, prepares his malachite green by the joint action of dimethyl aniline, chloride of zinc, and benzo-trichloride. Fischer, of

Munich, on the other hand, obtains the same dye by the reaction of dimethyl-aniline, chloride of zinc, and the oil of bitter almonds. Thus when rightly considered the inventions of these two chemists, though relating to the same substance, were distinct.

We may take another signal instance, which though belonging to the sphere of scientific discovery rather than technical industrial invention, still illustrates the same principle.

Not very long ago two eminent physicists, M. Cailletet and M. Pictet, succeeded almost simultaneously in condensing into a liquid state the permanent gases formerly so considered. But here, again, though the end gained was identical, the means employed were distinct. In this manner close and intelligent scrutiny will be found to dispose of a very large proportion of the alleged cases of simultaneous invention.

In another very numerous class of cases the simultaneity, or rather the invention altogether, is doubtful or spurious. There are a certain class of persons addicted to vague and aimless experimentation, whether chemical, physical, or mechanical, on any subject that engages public attention. Twenty years ago they were "messing about" with aniline, napthaline, and phenol, and obtaining products which they had not the skill and the perseverance to purify. Five years ago they were deep in the mystery of roller-skates, and now the electric light has dazzled their minds with its brilliance and its future. When a real improvement is originated in the matter with which such muddlers are engaged, it is very easy for them to say, and perhaps to think, that they too had tried the very reaction or combination in question, and in a few more weeks' or months' time they could have brought their ideas to perfection. It is hard to disprove such assertions. Oftentimes a claimant of this stamp can even prove that at the time in question he was working with such or such substances. But all this generally falls far short of a demonstration that an invention identical with one just claimed in a patent has been independently and distinctly originated by some other experimentator. It is very significant that these multiple or reiterated inventions arise only after some man of merit has paved the way. When Mr. Perkin brought out his original aniline violet no rival inventor complained of having been beaten by a neck. A few years later every fresh aniline dye became a bone of contention between candidates for priority.

Summing up the above considerations we find, therefore that one class of inventions is confessedly single in its origin; that in another the simultaneity of origination is only apparent; and that in a third it is spurious or doubtful. Thus, contrary to the view stated by Professor Rogers, a mere exceptional minority remains, where, save in point of time, a second person has an equal claim to the authorship of the invention. But even as regards this minority, the argument under examination proves nothing. Let us suppose that two chemists had independently and simultaneously effected the combination of atmospheric nitrogen with hydrogen so as to produce ammonia and ammoniacal salts at a greatly reduced cost. Let us further assume that each had arrived at this result by exactly the same process. In such a case the honour would fall equally to both. The beneficial interest in the invention, in default of omniscient patent-commissioners, falls to the one who first took date by petitioning for letters patent. This arrangement may not agree with the dictates of ideal equity, but is probably as near an approximation as is possible in human institutions. That A has completed an invention in January, and that B has independently originated the same invention in February, can certainly never justify C—the pirate, or idea stealer—in saying that it is therefore the property of neither. The "accident of priority," if accident it can be legitimately termed, is in many cases the very point upon which admitted property hinges. The mere fact that E is the eldest of the sons of D ensures his succession on the death of D to the real estate of the latter. Nor is the existence of primogeniture ever advanced as a reason why land should not be regarded as property.

In the case of islands or regions previously unknown, priority of discovery, registered by hoisting the national flag, has always been considered as giving the title to possession. Suppose that two ships, commissioned by different powers, were each in turn to discover one and the same guano island, no one would contend that the second discoverer was in any way "prejudiced" or entitled to call in question the right of his anticipator. Still less would it be argued that, because the island had been independently discovered by the vessels of two powers, it could become the property of neither.

A case still more closely analogous is afforded by the mining laws and customs of certain districts. Two or more persons may independently and almost simultaneously have become aware of the existence of an unclaimed and unwrought vein of tin or copper ore. But it becomes the property, subject to the payment of certain dues, of the man who first breaks ground. No one contends that his right is "to the prejudice" of the second discoverer, or blames him as a "monopolist," yet the mine is less truly the property of the finder than is the invention of its originator. The vein of ore had a prior existence, while the invention had not. These considerations will, we think, satisfy every disinterested man of the utter futility of the piratical argument drawn from the alleged simultaneity of invention.

Another ground brought forward for denying to inventors the character of property has been expressed as follows:—"What he (the landowner, or the fundholder, or, we suppose, the successful gambler) occupies, is something tangible and limited which *can* belong to him without his requiring to go out of his way or into any other person's way in order to watch it, work it, and profit by it. *True property* is manifestly a right to an existing thing, visible and palpable, that only a single person, or at the most a limited number of persons, can hold, occupy, employ and enjoy."

Here again the attempt to establish a difference between patent-right and property utterly fails. A patent, just like an estate, is generally in the hands of one person, and, just as the landowner can sell or let the whole of, or certain fractions, of his domain, so the patentee can assign or let the whole of his interest to one person or to a number. There is the closest analogy between the two cases.

Again, we admit that a patent is in itself nothing "visible, tangible, or palpable." But the same may be said of various kinds of recognised property. A. B. holds, for instance, ten shares in a manufacturing or banking company, or a thousand pound's worth of consols or of Egyptian bonds; where in these cases is the "existing thing visible and palpable?"

If this "existing thing" be the share certificates, they are simply analogous to the patentee's official document. The patentee, no more and no less than the landowner or fundholder, has to "go out of his way or into any other person's way" to watch, work, or profit by his possession. Other persons and their ways the inventor leaves as he finds them, except they wilfully and knowingly come out of such ways in order to trespass upon his novel creation. It is sometimes, with admirable simplicity, contended that patent-right is a privilege in restraint of trade. This is what every thief might say of the institution of property; it restrains him, to his great annoyance, from carrying off and selling his neighbour's goods and chattels.

There may be sometimes greater difficulty in defining the rights of a patentee than those of a landowner, though the boundaries, water-rights, and easements of estates have been a fruitful source of litigation. But if we, on that account, decline to recognise property in invention, we follow the example of a certain examinee—we will not say student—who, being unable to classify certain mineralogical specimens, got over the difficulty by throwing them away.

If the advocates of free-booting still refuse to recognise the property of the inventor in his creation, they should at least produce some more pertinent arguments in defence of their position. It is mainly by priority in invention that England's old industrial supremacy was gained, and if it is to be retained, or rather re-conquered, invention alone can point the way. A Bessemer, a Siemens, or a Perkin, is of more value to the country than all the professors of political economy and all the chambers of commerce that ever existed.

VII. THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

SHEFFIELD MEETING.

THE Meeting of the British Association at Sheffield, which closed on the 28th ult., though not so largely attended as the Dublin Meeting of last year, proved a very successful one. The arrangements of the Local Committee, of which Dr. H. C. Sorby, F.R.S., and Mr. J. F. Moss were the Secretaries, gave great satisfaction, and never has the Association been received with greater hospitality than by the Mayor and inhabitants of Sheffield.

At the concluding meeting it was announced that the grants of money appropriated to scientific purposes by the General Committee amounted to £960. The following is a list of the grants:—A. Mathematics and Physics: Dr. Lodge, new form of high insulation key, £10; Prof. Adams, standard of white light, £20; Prof. Everett, underground temperature, £10; Dr. Joule, determination of the mechanical equivalent of heat, £50; Sir W. Thomson, elasticity of wire, £50; Mr. Glaisher, luminous meteors, £30; Mr. G. H. Darwin, lunar disturbance of gravity, £30; Prof. Sylvester, fundamental invariants, £50; Mr. J. Perry, laws of water friction, £30; Mr. W. E. Ayrton, specific inductive capacity of Sprengel vacuum, £20; Rev. Prof. Haughton, completion of tables of sun-heat co-efficients, £50; Prof. G. Forbes, instrument for detection of fire-damp in mines, £10; Mr. J. M. Thompson, inductive capacity of crystals and paraffines, £25. B. Chemistry: Dr. Dewar, spectral analysis, £10; Dr. Wallace, development of light from coal gas, £10. C. Geology: Prof. Duncan, R.M., report on carboniferous polyzoa, £10; Prof. A. L. Adam, caves of South Ireland, £10; Prof. Seeley, viviparous nature of ichthyosaurus, £10; Mr. John Evans, Kent's cavern exploration, £50; Mr. John Evans, geological record, £100; Prof. W. C. Williamson, miocene flora of the basalt of North Ireland, £15; Prof. Hull, underground waters of Permian formations, £5. D. Biology: Dr. Pye Smith, elimination of nitrogen by bodily exercise, £50; Mr. Lane Fox, general anthropological notes, £20; Mr. Stainton, record of zoological literature, £100; Dr. M. Foster, table at zoological station at Naples, £75; Dr. A. Gamgee, investigation of the geology and zoology of Mexico, £50; Sir J. Lubbock, excavations at Port Stewart, £15. F. Statistics and Economical Science: Dr. Farr, anthropometry, £50. G. Mechanics: Mr. Bramwell, patent laws, £50. Total, £960.

On the motion of Mr. Sclater, seconded by Prof. Ramsay, it was resolved that the Council be authorised to take such further action, having regard to the correspondence with the Treasury as to the natural history collection, as they may deem necessary in the interests of science.

The following is an abstract of the Inaugural Address of the President, Prof. G. J. ALLMAN, M.D., LL.D., F.R.S., &c.:—

The PRESIDENT selected as his subject the most generalised expression of living matter, and gave an account of the results of the latest researches into its nature and properties. Some forty years ago, he said, Dujardin pointed out that the bodies of some of the lowest animals consist of a structureless semi-fluid, but contractile substance, which he named Sarcode. Mohl afterwards detected and studied a similar substance in the cells of plants, which he called Protoplasm. Schultze subsequently demonstrated that these two substances, the sarcode of animals and the protoplasm of plants, were identical. Recent research has not merely confirmed this conclusion of Schultze, but has shown that protoplasm lies at the root of all vital phenomena, whether animal or vegetable, constituting, as Huxley expresses it, the "physical basis of life." Wherever there is life there is

protoplasm, and conversely wherever there is protoplasm there is life.

Co-extensive with the whole of organic nature—every vital act being referable to some mode or property of protoplasm—it becomes to the biologist what "ether" is to the physicist, only that instead of being a mere hypothetical conception, accepted as a reality merely from its adequacy in explaining phenomena, it is a reality, visible and tangible.

The chemical nature of protoplasm is very complex, and not yet fully determined. It is, however, a combination of albuminoid bodies, its main elements being oxygen, carbon, hydrogen, and nitrogen. In its typical state it is a tenacious glairy liquid, in consistence something like the white of unboiled egg. Under the microscope it displays movements. Waves traverse its surface, or it is seen to flow away in streams of the most varied characters, not only in accordance with gravity, but in directions utterly opposed to gravitation. All these movements take place without any obvious impulse from without which might send ripples over its surface or set streamlets flowing from its margin. These phenomena are such as we never meet with in a simply physical fluid; they are spontaneous movements due to its proper irritability, to its essential constitution as living matter. On still closer examination it is found, if not absolutely homogeneous, still totally destitute of structure. It is a living liquid, which, though organless, manifests the essential phenomena of life.

Such is protoplasm in its most generalised aspect. The speaker then proceeded to give some examples of protoplasm as actually met with in Nature. He described the far-famed *Bathybius*, first dredged up in the North Atlantic by the naturalists of the exploring ship *Porcupine*, from depths of 5000 to 25,000 feet. This substance has been examined by Huxley and Haeckel, who pronounce it to be living protoplasm in its simplest and most primitive condition. On the other hand, the *Challenger* explorers met with no traces of this living matter,—for it can scarcely be called a living being,—and they conclude that it is merely a deposit of sulphate of lime, inorganic, and of course inanimate. Bessels, however, the naturalist of the *Polaris*, confirms the views of Huxley and Haeckel, and states that he dredged up from the Greenland Seas masses of protoplasm, living, but undifferentiated. Further research is here, therefore, required.

As a further and indisputable form of protoplasm we have *Protamœba primitiva*, little living lumps which multiply by spontaneous division.

A little higher is the *Amœba* of our pools and gutters, a being without definite shape, perpetually changing its form, throwing out and drawing in thick lobes and finger-like "false feet," in which its body seems to flow over the field of the microscope. It is no longer a mere homogeneous particle of protoplasm, like the *Protamœba*. Towards its centre a small globular mass of firmer matter has become differentiated from the remainder, forming a nucleus, while the protoplasm constituting the extreme outer boundary differs slightly from the rest, being more transparent, destitute of granules, and apparently somewhat firmer than the interior. We may also notice that at one spot a clear spherical space has made its appearance. On watching we see it suddenly contract and vanish, and after a few seconds it dilates, comes into view, and again disappears,—all this in regular rhthymic sequence. This pulsating cavity is the "contractile vacuole." In the *Amœba* we have the essential characters of a *cell*, the morphological unit of organisation and the physiological source of specialised function. The term "cell" is, however, somewhat misleading; it denotes merely a definite mass of protoplasm containing a nucleus, which may or may not assume the form of a vesicle. To the non-nucleated forms of life, such as *Protamœba*, Haeckel assigns, in distinction, the name Cytode. Many aquatic beings beside the *Amœba* never pass beyond the condition of a simple cell, in which reside the whole of the properties which manifest themselves in the vital phenomena of the organism. As we pass from these lowest forms to higher we find cell added to cell, until many millions of such units become associated in a single organism, where each cell or group of cells has its special work, while all combine for the welfare and unity of the whole. Still even in man the component cells are far from losing their individuality. The colourless blood-corpuscules retain most of the characters of the *Amœba*.

The animal egg, which in its young state forms an element in the structure of the parent organism, is a true cell, consisting of a lump of protoplasm enclosing a nucleus, and having in the interior of this a nucleolus. Whilst still very young it has no constant form, and may, like an *Amœba*, wander about by the aid of its pseudopodial projections. The life of an organism is made up of the lives of its component cells, and here we find most distinctly expressed the great law of the physiological division of labour. In the lowest unicellular organisms the performance of all the processes which constitute its life must devolve on the protoplasm of this one cell; but as we pass to more highly organised beings the work is distributed among a number of workers,—to wit, the cells which make up the complex organism. No cell, however great may be the differentiation of function in the organism, can dispense with its irritability, the one constant and essential property of every living cell. In very many instances the protoplasm becomes confined within resisting walls, composed in plants of cellulose, still losing none of its activity, as is manifest in the Characeæ, in *Valisneria spiralis*, and even in higher plants. Even in these higher plants, further, truly naked protoplasm still occurs, as has recently been shown by Mr. F. Darwin in the teazel (*Dipsacus*)—a phenomenon probably connected with the absorption of nitrogenous matter.

That there is no essential difference between the protoplasm of plants and of animals is rendered plain by a number of motor phenomena which we have been in the habit of erroneously regarding as peculiar to animals. All living protoplasm alike possesses the property of resisting the entrance of colouring-matter into its substance, though as soon as dead it can be coloured throughout.

Recent researches on the division of animal cells show how close is the agreement between plants and animals in all the leading phenomena of cell-division, and afford further proof of the essential unity of the two great organic kingdoms. The egg, as a typical cell, distinguishable by no tangible characters from thousands of other cells, is nevertheless destined to run through a definite series of developmental changes which have as their end the building up of an organism like that to which the egg owes its origin. It is obvious that such complex organisations as thus result can be derived from the egg-cell only by a process of cell-multiplication. The birth of new cells derived from the primary cell or egg thus lies at the basis of embryonic development. It is here that the phenomena of cell-multiplication in the animal kingdom can be most successfully observed.

The PRESIDENT then briefly described the so-called "cleavage" of the egg, which is merely a multiplication of the egg-cell by repeated division. The egg has its protoplasm and its nucleus, and is, as a rule, enveloped in a delicate membrane. The protoplasm forms the vitellus or yolk, and the surrounding membrane is called the vitellary membrane. The division about to take place is introduced by a change of form in the nucleus, which assumes the shape of a spindle precisely as in the cell-division of plants. On each pole of the spindle transparent protoplasm collects, forming here a clear spherical area. Each pole of the spindle has become the centre of a system of rays, which stream out in all directions into the surrounding protoplasm. The protoplasm thus shows enveloped in its mass two sun-like figures, whose centres are connected to each other by the spindle-shaped nucleus. To this, with the sun-like rays streaming from its poles, Auerbach gives the name of "Karyolitic figure." A phenomenon very similar to what occurs in cell division among plants now shows itself. The nucleus becomes broken up into a number of filaments which lie together in a bundle, each filament stretching from pole to pole of the spindle. In its central point each filament shows a knot-like enlargement, and from the close approximation of the knots there results a thick zone of protoplasm in the equator of the spindle. Each knot soon divides into two halves, and each half recedes from the equator and travels along the filament towards its extremity. When arrived at the poles of the spindle each set of half knots coalesces into a globular body, while the intervening portion of the spindle gradually disappears. Instead of the single fusiform nucleus whose changes have thus been traced, we have two new globular nuclei. The egg now begins to divide along a plane at right angles to a line connecting the two nuclei. The division is introduced by a constriction of its protoplasm commencing at the circumference just within the vitelline membrane, and extending towards the centre, divides the whole mass of protoplasm into halves, each including within it one of the new nuclei. Each of these two young cells divides in its turn in a direction at right angles to the first division-plane, while by continued repetition of the same act the whole of the protoplasm or yolk becomes broken up into a vast multitude of cells, and the unicellular organism—the egg with which we began our history—has become converted into an organism composed of many thousands of cells.

In the greater number of plants the protoplasm of most of the cells exposed to sunlight undergoes an important differentiation, part of it becoming separated from the remainder in the form of green granules known as chlorophyll granules. These consist of true protoplasm, as the green colouring-matter may be extracted, leaving behind the colourless protoplasmic base. That chlorophyll is a living substance is sufficiently obvious. On the cells which contain it devolves the faculty of decomposing carbonic acid. On this depends the assimilation of plants—a process externally manifested by the exhalation of oxygen, which occurs under the influence of light. This action of chlorophyll in bringing about the decomposition of carbonic acid is not, as was till recently believed, confined to plants. In the green *Hydra*, and in certain green Planariæ, chlorophyll is differentiated in their protoplasm, and probably always acts here under the influence of light exactly as in plants. Geddes has shown that these animals contain starch-grains in their tissues—another striking point of resemblance between them and plants. A further approximation between the two organic kingdoms has been shown by the researches of Mr. Darwin and others on carnivorous plants. Naegeli has further proved that the cell of the yeast fungus contains peptin, a substance formerly known solely as a product of the digestion of nitrogenous food of animals.

Nothing shows more strikingly the identity of the protoplasm in plants and animals than the fact that plants may be placed, like animals, under the influence of anæsthetics. Plants while under this influence absorb oxygen and exhale carbonic acid, the true *respiratory* function which is ordinarily masked by the predominant function of *assimilation*, which devolves on the green cells of plants, and which manifests itself under the influence of light in the absorption of carbonic acid and the exhalation of oxygen. Hence the respiration of living beings is identical whether manifested in the plant or the animal, and the supposed antagonism in its respective character is totally demolished.

Enough has been said to show that in protoplasm we find the only form of matter in which life can manifest itself. We are thus led, said Prof. ALLMAN, to the conception of an essential unity in Organic Nature,—a structural unity in as far as every living being has protoplasm as the essential matter of every living element of its structure, and a physiological unity in the universal attribute of irritability, which has its seat in this same protoplasm, and is the prime mover of every phenomenon of life. Mere form has little to do with the essential properties of protoplasm. To suppose that all protoplasm is identical where no difference can be detected by the means at our disposal would be an error. Of two particles of protoplasm between which we can detect no difference, one can develop only to a jelly-fish, the other only to a man; and one conclusion alone is possible—that deep within them there must be a fundamental difference which thus determines their destiny. Of this we know nothing, and can assert nothing beyond the statement that it must depend on their hidden constitution. In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs in the most highly differentiated organisms. Herein lies the many-sidedness of protoplasm, and its significance as the basis of all morphological expression, as the agent of all physiological work. From the facts which have been here briefly noticed there is but one legitimate conclusion—that life is a property of protoplasm. The essential phenomena of living beings are not so widely separated from the phenomena of lifeless matter as to render it impossible to recognise an analogy between them. Even irritability, the one grand character of living beings, is not more difficult to be conceived of as a property of matter than the physical phenomena of radial energy. It is quite true that between lifeless and living matter there is a difference greater far than any which can be found between the most diverse manifestations of lifeless matter. No one has ever yet built up one particle of living matter out of lifeless elements. Every living creature has its origin in pre-existent living matter; the protoplasm of to-day is but the continuation of the protoplasm of past ages. When we say that life is a property of protoplasm we assert as much as we are justified in doing. We stand upon the boundary between life in its proper conception, as a group of phenomena having irritability as their common bond, and that other group of phenomena which we call consciousness or thought, and which, however closely linked with those of life, are yet essentially distinct from them. When a thought passes through the mind it is associated, as we have reason for believing, with some change in the protoplasm of the cerebral cells. Are we therefore justified in regarding thought as a property of the protoplasm of these cells, in the sense in which we regard muscular contraction as a property of the protoplasm of the muscle? or is it really a property residing in something far different, but which may yet need for its manifestation the activity of cerebral protoplasm?

If, said the PRESIDENT, we could see any analogy between thought and any one of the admitted phenomena of matter, we should be bound to accept the first of these conclusions as the simplest, and as affording a hypothesis most in accordance with the comprehensiveness of natural laws. But between thought and the phenomena of matter there is not only no analogy, but there is no conceivable analogy, and the path we have hitherto followed comes to an end. The chasm between unconscious life and thought is impassable; for even from irritability, to which on a superficial view consciousness may seem related, it is as absolutely distinct as it is from the ordinary phenomena of matter. It has been argued that because physiological activity must be a property of every living cell, psychical activity must be equally so; the language of the metaphysician has been carried into biology, and the "cell-soul" spoken of as a conception inseparable from life. How far back in the scale of life consciousness may exist, we have no means of determining. But even admitting that every living cell were a conscious, thinking being, are we therefore justified in asserting that its consciousness, like its irritability, is a property of the matter of which it is composed? The sole argument on which this view rests is that from analogy, and as there is an absence of all analogy between the things compared it must fall to the ground.

Prof. Huxley, in his lecture on the "Physical Basis of Life," contended that no difference, however great, between the phenomena of living matter and those of the lifeless elements of which such matter is composed, should militate against our ascribing to protoplasm the phenomena of life as properties essentially inherent in it; since we know that the result of a combination of physical elements may exhibit physical properties totally different from those of such elements, the physical phenomena presented by water having, *e.g.*, no resemblance to those of oxygen and hydrogen, As regards the phenomena of life in the stricter sense of the word, the argument is conclusive. But if it be pushed further and extended to consciousness it loses all its force.

That consciousness is never manifested except in the presence of cerebral matter or of something like it, there cannot be a question; but this is a very different thing from its being a property of such matter in the sense in which polarity is a property of the magnet, or irritability of protoplasm. The generation of the rays which lie invisible beyond the violet in the spectrum of the sun cannot be regarded as a property of the medium which by changing their refrangibility can alone render them apparent.

I know that there is a special charm in those broad generalisations which would refer many very different phenomena to a common source. But in this very charm there is undoubtedly a danger, and we must be all the more careful lest it should exert an influence in arresting the progress of truth, just as at an earlier period traditional beliefs exerted an authority from which the mind but slowly and with difficulty succeeded in emancipating itself.

But have we, it may be asked, made in all this one step forward towards an explanation of the phenomena of consciousness or the discovery of its source? Assuredly not. The power of conceiving of a substance different from that of matter is still beyond the limits of human intelligence, and the physical or objective conditions which are the concomitants of thought are the only ones of which it is possible to know anything, and the only ones whose study is of value.

We are not, however, on that account forced to the conclusion that there is nothing in the universe but matter and force. The simplest physical law is absolutely inconceivable by the highest of the brutes, and no one would be justified in assuming that man had already attained the limit of his powers. Whatever may be that mysterious bond which connects organisation with psychical endowments, the one grand fact—a fact of inestimable importance—stands out clear and freed from all obscurity and doubt, that from the first dawn of intelligence there is with every advance in organisation a corresponding advance in mind. Mind as well as body is thus travelling onwards through higher and still higher phases; the great law of Evolution is shaping the destiny of our race; and though we may at most but indicate some weak point in the generalisation which would refer consciousness as well as life to a common material source, who can say that in the far-off future there may not yet be evolved other and higher faculties from which light may stream in upon the darkness, and reveal to man the great mystery of Thought?

The first Evening Discourse was by Mr. Crookes, F.R.S., "On Radiant Matter:" the second by Prof. Ray Lankester, F.R.S., "On Degeneration;" while the Saturday evening Lecture to Working Men was delivered by Mr. W. E. Ayrton, the subject being "The Transmission of Power by Electricity."

Mr. Crookes's discourse was illustrated by experiments on the movements of molecules in high vacua, some of which were recently described in the "Monthly Journal of Science." According to the best authorities, a bulb 13·5 centimetres in diameter contains more than 1,000000,000000,000000,000000 (a quadrillion) molecules. Mr. Crookes showed that when exhausted to a millionth of an atmosphere there are still a trillion molecules left in the bulb. To suggest some idea of this vast number he perforated an exhausted bulb by a spark from the induction coil. The spark produced a hole of microscopical fineness, yet sufficient to allow molecules to penetrate and to destroy the vacuum. The inrush of air impinged against the vanes and set them rotating after the manner of a windmill. "Let us suppose," said Mr. Crookes, "the molecules to be of such a size that at every second of time a hundred millions could enter. How long, think you, would it take for this small vessel to get full of air? An hour? A day? A year? A century? Nay, almost an eternity! A time so enormous that imagination itself cannot grasp the reality. Supposing this exhausted glass bulb, indued with indestructibility, had been pierced at the birth of the solar system; supposing it to have been present when the earth was without form and void; supposing it to have borne witness to all the stupendous changes evolved during the full cycles of geologic time, to have seen the first living creature appear, and the last man disappear; supposing it to survive until the fulfilment of the mathematicians' prediction that the Sun, the source of energy, four million centuries from its formation will ultimately become a burnt-out cinder; supposing all this,—at the rate of filling I have just described, 100 million molecules a second,—this little bulb even then would scarcely have admitted its full quadrillion of molecules.[*] But what will you say if I tell you that all these molecules, this quadrillion of molecules, will enter through the microscopic hole before you leave this room? The hole being unaltered in size, the number of molecules undiminished, this apparent paradox can only be explained by again supposing the size of the molecules to be diminished almost infinitely—so that instead of entering at the rate of 100 millions every second, they troop in at a rate of something like 300 trillions a second. I have done the sum, but figures when they mount so high cease to have any meaning, and such calculations are as futile as trying to count the drops in the ocean." Mr. Crookes concluded his lecture by remarking that at length we seemed to have within our grasp and obedient to our control the little indivisible particles which with good warrant are supposed to constitute the physical basis of the universe. We had seen that in some of its properties Radiant Matter was as material as the table, whilst in other properties it almost assumed the character of Radiant Energy. We had actually touched the border land where Matter and Force seem to merge into one another, the shadowy realm between Known and Unknown which for him had always had peculiar temptations. He ventured to think that the greatest scientific problems of the future would find their solution in this Border Land, and even beyond; here, it seemed to him, lay Ultimate Realities, subtle, far-reaching, wonderful.

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[*] Mr. Johnstone Stoney has shown (Phil. Mag., vol. xxxvi., p. 141) that 1 c.c. of air contains about 1000,000000,000000,000000 molecules. Therefore a bulb 13·5 centims. diameter contains $13{\cdot}5^{2} \times 0{\cdot}5236 \times 1000,000000,000000,000000$ or 1,288252,350000,000000,000000 molecules of air at the ordinary pressure. Therefore the bulb when exhausted to the millionth of an atmosphere contains 1,288252,350000,000000 molecules, leaving 1,288251,061747,650000,000000 molecules to enter through the perforation. At the rate of 100,000000 molecules a second, the time required for them all to enter will be

12882,510617,476500 seconds, or
214,708510,291275 minutes, or
3,578475,171521 hours, or
149103,132147 days, or
408,501731 years.

The Mathematical and Physical Section was presided over by Mr. G. JOHNSTONE STONEY, M.A., F.R.S.

In his presidential address Mr. STONEY sought to show that in the study of mechanics and chemistry the two great methods of investigation, viz., the deductive and the experimental, could best be acquired, and that for a sound grasp of the remaining physical sciences, and especially with a view to further advance in physical science, a command of both methods of investigation is essential. He said that, in order to understand the present position of Natural Science upon the earth, we must remember that the universe is in itself one great whole, which includes minds no less than bodies, for thought is as much a phenomenon of what really exists as motion. But though the universe be but one, man with his limited powers is unable to treat it as such, but has to push his investigation of Nature when and where he can. Thus have arisen many sciences which were at first quite isolated. Their separate condition is a mark of the feebleness of our powers of investigation. Their gradual convergence, and especially where any complete contact can be established between them, is the mark that our advancing knowledge is penetrating deeper.

In the present passing condition of our knowledge then there is one group of sciences which investigate the phenomena of consciousness; another distinct group of the biological sciences; and a third, the group of the physical sciences. These are all but parts of the one great investigation of Nature, but for the present they exist almost disconnected, as separate provinces of human inquiry.

When we endeavour to investigate mental phenomena, we are encountered by the complexity and remoteness of the effects which present themselves for examination, and by a deep and unpenetrated obscurity hanging over the interval between them and their causes. In order to make any progress even in the subordinate task of tracing out the relations of these effects to one another, the inquirer finds it necessary to venture upon hypothesis, and in all metaphysical speculation we sadly miss that healthy discipline with which Nature in other branches of science relentlessly refutes our hypotheses if they are wrong. Here, then, is a region in which the plausible may be mistaken for the true; and it is unfortunately certain that it has sometimes been so mistaken by the ablest human minds.

The biological sciences treat of all the phenomena of living beings except their mental phenomena, which are those which lie most remote from their causes. Here the complication is less, but it is still too great for the human mind to have yet penetrated behind it. We are still occupied with phenomena which lie at a great distance from their real causes. We are accordingly still far beyond the range of the exact sciences. Most of the great discoveries of biological science have been made by estimating the *general drift* of what is taught by a vast number of particular facts. This, it will be observed, is a kind of reasoning that is necessarily more or less inexact, and, as a consequence, it is one which requires wide intellectual training and great experience and tact to handle it with safety. When the investigator has brought these qualifications to his task, astonishing progress has been made in these sciences: without them the reasoning may degrade into being either trivial or loose.

In the rest of the study of Nature we are not embarrassed by the phenomena of life, and many mysteries therefore stand aside out of our path. Here lies the domain of the physical sciences. It is here that the mind of man has best been able to cope with the realities of the universe, and in which its greatest achievements have been effected. It is here that exact reasoning finds a predominant place.

In meteorology, owing to the complication of the materials that have to be dealt with, we must have frequent recourse to the same kind of reasoning as has been found so effectual in the biological sciences; but in the other physical sciences exact reasoning prevails, and on this account they are frequently classed together as the exact sciences.

The process of investigation in the exact sciences is fundamentally one in all cases. It has been well described by Mill in the third book of his "Logic." Nevertheless, it is notorious that minds which are well fitted for some branches of physical inquiry find difficulty—sometimes insuperable difficulty—in pursuing others. It is not every eminent mathematician who would have made an equally good chemist, or *vice versa*. This is because there exists a practical distinction separating the investigation of exact science into two well-marked classes when they are viewed, not as they are in themselves, but in their relation to the powers of us human beings. All valid investigations in exact science appeal to what can be directly perceived, and all lead to a conclusion which can be reasoned out from it; but there are some of these investigations in which the main difficulty consists in making the appeal to the senses, and there are others in which the main difficulty lies in the process of reasoning.

To contend with these difficulties successfully requires very different qualities of mind and body. In experimental science the powers principally called into requisition are readiness and closeness of observation, dexterity in manipulation, skill in devising expedients, accuracy in making adjustments, and great patience. It also requires that the investigator should have an accurate memory of what else he has witnessed resembling the phenomenon under observation, that he should be quick to detect every point of agreement and difference that can be perceived, and be skilful to select those which are significant, and to employ them as materials for provision to guide his further proceedings. But the strain on the reasoning powers is generally less, often of trifling amount. The question is put to Nature, and it is Nature usually that gives the bulk of the answer. The most striking monument of splendid achievements by the experimental method of investigation unaided by the deductive method is to be found in the science of chemistry.

An equally typical instance of the power of the deductive method is the science of mechanics. This science, which has sunk deeper into the secrets of Nature than any other science, and which is the science towards whom all other physical sciences are at present more or less gravitating, is essentially deductive. There is little or no difficulty about its fundamental data. They are facts of Nature so patent to all men, and so indelibly implanted in human conception, that some persons have supposed that we have an intuitive perception of them. But, while the materials from which the mind is to work are thus easily obtained, it has taxed to the utmost the reasoning powers of understandings like Newton's to evolve the few consequences of them which are already known, and the investigator has to call to his assistance every aid to prolonged consecutive thought which mathematicians can devise.

No reach of intellect applied to the materials in existence before 1860 could have elicited the fact that iron exists upon the sun. This great discovery was made by Professor Kirchhoff, a scientific man who was equally versed in both methods of investigation. It was the experimental method he employed. Kirchhoff's great merit and the real difficulty of his work lay in the scientific foresight and the industry which were required to frame hypotheses that were worth testing, to guide the investigation by these hypotheses, to contrive, construct, and adjust adequate apparatus, and to make with it the elaborate observations and the exact observations and maps which were necessary. But when by these means the new facts had been brought to light, the inference from them that there is iron in the atmosphere of the sun was an easy one. This example will better convey than a definition what are the characteristic features of an experimental inquiry.

On the other hand, no series of observations or experiments, however skilfully arranged, could have enabled anyone to understand the cause of that familar but truly surprising phenomenon that a top stands upon its peg while it is spinning. But a full explanation of it is within the reach of any student who will train his mind to reason consecutively, and avail himself of the aids to prolonged consecutive thought which mathematicians have contrived. He will then see that the most obvious and familiar mechanical facts involve as necessary consequences all the phenomena which he finds in the schoolboy's top, in the physicist's gyroscope, and in the precision and nutation of the heavens. This, then, is a problem of Nature which falls within the province of the deductive method.

Whatever data are known exactly, these inferences from these data, however remote, may be depended upon as corresponding with what actually occurs in Nature. And if in such cases the mind of man has proved equal to the task of drawing inferences which can effectually grapple with the problems he finds around him in the Universe—which is, alas! as yet but too seldom—then will the deductive method, our plummet, explore depths in the great ocean of existence which our anchors of experiment could not have reached.

We must bear in mind that either method of investigation may be misapplied, and that this is a risk carefully to be guarded against. The deductive method when misapplied lands us in speculation; the experimental method becomes empiricism; and it so happens that the sciences of mechanics and chemistry are not only monuments of the power of the two great methods of investigation, but instructive examples of their weakness also. For in chemistry scarce any attempt at prolonged reasoning, carrying us by any lengthened flight to a distance from the experiments, can be relied on. The result has seldom risen to anything better than speculation. And, on the other hand, in mechanics, conclusions which depend on experiments only are empirical; that is, they are deficient in accuracy, and their relation to the other phenomena of the science is left in darkness. Here, then, we find in these two sciences not only how strong these two methods of investigation are, but how weak they may become if misapplied.

In the study of mechanics, however, and in the practice of chemistry, the two great methods of investigation may be studied separately, by steps of graduated difficulty, and with a superabundance of materials; and each of them supplies the necessary cautions with respect to the method which is all powerful in the other. No scientific man is really equipped for the pursuits in which both methods have to be employed till he has separately acquired a grasp of each. For it is only then that he will be armed against the errors which lead so many to mistake empirimism on the one hand, and speculation on the other, for solid science, or to underrate solid science, mistaking it for speculation. Nor is it only in his scientific occupations that he will derive benefit from this training. All exact reasoning, whether in science or in common life, belongs to these great divisions; and in the numberless instances in which we must be satisfied with reasoning which falls short of being exact, our only safety lies in having by the practice of exact reasoning, both deductive and experimental, attained to that intellectual tact and caution which alone will enable us to handle with safety the sharp and slippery tool. It is thus that a sound judgment with regard to truth may best be acquired by man or woman; and soundness of judgment is the noblest endowment of man's understanding, just as veracity is first among his virtues.

We shall conclude our report of the Proceedings of the Association in our next issue.

NOTICES OF BOOKS.

Fragments of Science: A series of detailed Essays, Addresses, and Reviews. By John Tyndall, F.R.S. Sixth edition. London: Longmans and Co. 1879.

This valuable collection of scientific essays now appears in the form of two substantial volumes, containing articles contributed to various magazines, Royal Institution lectures, and the celebrated Belfast Address. The range of subject-matter is very large: physics proper, chemistry, geology, philosophy, and even theology, are discussed in one or other of the articles. While the first volume deals specially with the phenomena of matter; the second treats of the correlation of phenomena of mind and matter. In the preface to this edition the author says: "In neither volume have I aspired to sit in the seat of the scornful, but rather to treat the questions touched upon with a tolerance, if not a reverence, befitting their difficulty and weight."

In the first volume, the author introduces various contributions to molecular physics; experiments on para-magnetic and diamagnetic forces; on dust and disease; and on fog signals. The memoirs of Faraday, Mayer, and Joule also appear; and the first article discusses spiritualism. In the second volume we find the well-known articles on scientific materialism, on the efficacy of prayer, and on the scientific use of the imagination. The Belfast Address, the apology for it, and the reply to the Rev. James Martineau's essay on the subject, are also here given. Then follow various lectures on fermentation, the germ-theory, and spontaneous generation, and the book is concluded by the lecture on the electric light delivered at the Royal Institution in January last. We feel sure that although the essays on materialism and prayer will offend the sensibilities of many readers, these fragments of science will continue to receive a large share of public attention.

Researches on the Motion of the Moon, made at the United States Naval Observatory, Washington. By Simon Newcomb, Prof. U.S. Navy. Part I. Washington. 1878.

This first part of what will be a very lengthy and valuable monograph relates to the reduction and discussion of observations of the moon before 1750. An historical introduction is followed by an account of various ancient eclipses of the sun and moon, beginning with the eclipse of Thales, passing on to the Ptolemaic eclipses of the moon recorded in the Almagest, and the Arabian observations, as given in the writings of Ebu Gounis. These are followed by the observations of Bullialdus, Gassendus, and Hevelius, and the astronomers of the French School before 1750. A technical mathematical discussion of the moon's mean motion and of the value of the secular acceleration concludes this portion of a work which will be welcomed by astronomers in every part of the world.

A Treatise in Popular Language on the Solar Illumination of the Solar System. By COLLYNS SIMON. Williams and Norgate. 1879.

THE contents of this work is so very fully set forth in the title page, and we can have so little to say to such a treatise, that we confine our notice to a transcript of the title page:—"The solar illumination of the solar system, or the law and theory of the inverse squares; being an analysis of the two received laws relating to the diminution of light by distance, wherein it is shown that, according to undisputed facts of nature and of science, the solar illumination is equal throughout the whole system, and the law of inverse squares for light, physically impossible. To which is added the prospectus for a prize of fifty guineas offered for disproof of the scientific facts here for the first time indicated."

In the same category we must place Mr. Orson Pratt's "Key to the Universe, or a new theory of its mechanism founded upon a continuous orbital propulsion, arising from the velocity of gravity and its consequent aberrations, and the resisting ethereal medium of variable density."

Dreams of my Solitude on the Mysteries of the Heavens. By JOSHUA PRUSOL. London: Reeves and Turner. 1879.

THIS work, of a severely essaic type, may commend itself to certain dreamers who are not *au courant* with the courses and ways of modern science. Although highly imaginative, it is not devoid of profound thought, and we cannot too highly praise the singular modesty of the preface; specially of the concluding sentence, in which the author says, "Dear, naturally, as these speculations are to him, the truth is dearer, and according as they consort or do not consort with it, does he expect others to give them entertainment, or undertake to denounce and repudiate them himself."

Navigation and Nautical Astronomy, with Special Table, Diagram, and Rules adapted for Navigating Iron Ships. By the Rev. W. T. READ, M.A. London: Elliot Stock. 1879.

AN useful work containing many original examples, and well adapted for teaching young naval officers the first principles of navigation.

The Electric Light in its Practical Applications. By PAGET HIGGS, LL.D., D.Sc. London: E. & F. N. Spon. 1879.

THIS work is specially devoted to a description of the various attempts which have been made to obtain a practicable system of electric lighting. An introductory chapter on the general principles of the voltaic arc and the method of lighting by incandescence is followed by chapters on electric lamps and candles; magneto and dynamic machines and their efficiency, and electric regulators; the division of the electric light is briefly discussed, and finally the commercial aspect of the question, and the various applications to military, maritime, mining, and other purposes.

In the first chapter the avoidance of waste of light is much insisted on, and the author asserts that when the laboratory of the Sorbonne was first lighted by electric candles "at least one-half of the light produced" was lost by radiation towards the sky through the glass roof of the building which served to light it during the day. The loss by this means in the case of an open-air light exposed at a considerable elevation, and unfurnished with reflectors, must be enormous. In the second chapter the various voltaic-arc lamps are described and figured; the last-mentioned of these—Higgs's lamp—is said to produce, with only four ordinary Bunsen elements, sufficient light to illuminate a building 60 feet by 40, and, when worked by a dynamo-electric machine of 2½ horse power, to produce four lights each equal to 400 candles. It simultaneously utilises the principles of incandescence, of the arc, and of the extra spark. Among the candles and candle lamps of course Jablochkoff's candle is the most prominent. It was invented in 1876, and has the special advantage that it entirely dispenses with any kind of mechanism. In fact, the candle simply consists of two cylindrical rods of carbon, about three-sixteenths of an inch in diameter, and from 6½ to 10 inches in length; they are placed vertically side by side, with a space of three-sixteenths of an inch between them, which is filled with plaster-of-Paris. The latter is fused as the arc passes at the extremity of the candle, and this fusion absorbs 30 per cent of the electric current; moreover, the candle, if once extinguished, cannot be re-lighted. With a light equal to 760 candles, three inches of carbon are consumed per hour. Wilde has modified Jablochkoff's candle, by removing the insulating plaster-of-Paris. The lamps for lighting by incandescence alone have not at present made much way.

In the fifth chapter the general principles of magneto and dynamo-electric machines are fully discussed. Commencing with the machines of Pixii and Clarke, and ending with those of Gramme, Edison, and Lontin-Siemens machine is effective, but it can only be used with one Serrin's or Siemens's lamp. It is said to give the following results:—

Revolutions per minute.	Illuminating power. Standard candles.	Horse power.	Weight.
850	1,200	2	280
650	6,000	4	420
360	14,000	8	1,288

Useful tables showing the efficiency of different forms of dynamo-electric machines are given on pp. 133, 136, 138, 140, 143, and 149. The highest recorded efficiency of a dynamo-electric machine is 38 per cent., while the efficiency of an ordinary steam engine in utilising the heat of the fuel does not exceed 20 per cent. The power expended by a dynamo-electric machine in producing the light of one sperm candle is about equivalent, according to the author, to 90 lbs. falling through one foot in one minute.

Some very interesting details as to the loss of production of the electric light compared with gas are given in the ninth chapter. The cost in Paris is said to be double that of an equally intense street lighting by gas. One electric light can usually be substituted for ten or twelve gas jets. The power absorbed is equal to one horse-power per candle. The subject of electric carbons is discussed in the last chapter. Archereau mixes carbon with magnesia. Carré with different salts. Those of potash and soda at least double the length of the arc. Gaudoin introduces phosphate of lime and various silicates and borates; others have coated the carbons with a deposit of metal such as nickel or copper, or have incorporated iron or copper in powder with the carbon. Gramme's experiments with carbons saturated with nitrate of bismuth proved that a considerable increase of light resulted.

Mr. Higgs's work gives us a very fair *resumé* of the whole subject of electric lighting, accompanied by an impartial discussion of the subject, and illustrated by excellent and numerous woodcuts. The perusal of the book forcibly impresses upon us the belief that the subject is still quite in its infancy, and that if the advances of the next fifteen years are as great as those of the last fifteen, we may expect to see gas very largely replaced by electricity.

The Student's Text Book of Electricity. By HENRY M. NOAD, F.R.S. A new edition. Edited by W. H. PREECE. London: Crosby Lockwood and Co. 1879.

THIS well-known work has been carefully edited by Mr. Preece, who has supplied new chapters containing a description of the most recent developments in all branches of electricity. The principles of duplex and quadruplex telegraphy, of the various electric lamps and candles, and of the telephone, and microphone have been fully explained, and constitute some of the most valuable portions of a book which will meet the requirements of a large number of students now as heretofore.

Four Lectures on Static Electric Induction. By J. E. H. GORDON, B.A. London: Sampson Low and Co. 1879.

THESE lectures, delivered at the Royal Institution, contain, as the author truly remarks, an account of a few phenomena which we can explain, and of a great many which we cannot. The results, however, have been discussed in a very suggestive and able manner, and the work cannot fail to recommend itself to all students of electricity. The more so when we remember that since the memorable monographs of Faraday comparatively little has been written on static electrical induction.

Mechanics. By R. S. BALL, F.R.S., Royal Astronomer of Ireland. London: Longman and Co. 1879.

THIS volume belongs to the "London Science Class Books" Series, and is carefully written and well illustrated. It will be useful for the higher forms in our public schools. The style is good, and the subject is not overburdened by mathematical treatment. A fair example of the lucid explanation and admirable illustration of a subject will be found under the head of "friction on the inclined plane" (pp. 92, 93.)

Outlines of Geology and Geological Notes of Ireland. Being an Account of the Formation and Localities of its Mineral Resources. With an Addenda, containing Disintegration of Rock, Antiquity of the Earth, Climatic Changes of the Earth, Supposed Antiquity of Man, and the author's concluding Note. By WILLIAM HUGHES. Third edition. Dublin: M. H. Gill and Son, and W. H. Smith and Son.

WE have here a manual of the mineral resources of Ireland, along with descriptions and illustrations of the wild and sublime scenery of its coasts. Such a work, doubtless, might serve the very important purpose of drawing the attention of its readers to the great truths of geology and leading them on to become observers. So far as the author confines himself to a description of facts we can follow him with approval. But when he enters upon speculation and theory we are compelled to put in our protest. Mr. Hughes is in the first place a catastrophist of a school which we had supposed extinct. He declares that "this earth was subjected to repeated changes, that thousands of years intervened between them, and that each completely destroyed all vegetable and animal life." To him the history of our globe is not a career of regular development, but an alternation of extirpations and creations, separated by "periods of repose." It might have been hoped that notions so irreconcilable with recent discoveries and observations would no longer be reproduced in a popular treatise.

We are unfavourably impressed, too, with the apologetic tone of the work and with its vacillating character. At one moment the author seems to have fully grasped the great truth that "revelation was given not to inculcate physical science," but the next he is reconciling geology with Genesis—a process which his former admission ought to render needless. On the supposed high antiquity of the human race he declares (p. 117) that "we must leave our readers to draw their own conclusions from the evidences we have laid before them;" but, in his concluding note, he withdraws this permission and declares, "To those whose minds are not warped (!) there can be no doubt whatever but that man's appearance upon this terrestrial scene is as we have been all taught to believe it, and as Holy Writ gives it in the simple narrative of the creation." So then, in this respect at least, "revelation has been given to inculcate physical science."

Though holding very positively the belief that the interior of our globe is in a state of igneous fusion, he does not appear to accept the nebular hypothesis, since he repeatedly speaks of the earth being first "launched into space" and likewise suggests that it may have existed for ever.

Descending to matters more closely connected with daily life, we find Mr. Hughes adopting the theory, first broached, we believe, by Prof. Hull, that the seams of coal formerly occurring in Ireland have been transferred to Britain! That the central limestone plain of Ireland was once covered over with carboniferous beds, so that these strata have been gradually denuded by the action of water and other agencies we do not dispute. It seems to us, however, that if a region of coal-seams, intersected and separated from each other by beds of shales, sandstones, &c., were carried, little by little, into the adjoining ocean, and there deposited, we should not find them there rearranged in distinct layers. Coal, shale and grit-stones would be all comminuted and blended together in confusion. Prof. Hull, it must not be forgotten, only gives a questioning adhesion to this wild hypothesis, since he speaks of the Irish strata as forming "perhaps some of the strata which were being piled up over the ocean-bed of the British area." What good cause can be shown that the British coal-seams were not formed from vegetable matter *in situ?*

What shall we say of this passsge: "All his (Voltaire's) ingenuity was employed to oppose the Mosaic account of the creation and the deluge; for instance, he asserts that the shells discovered in Alpine regions are simple freaks of nature, or else they were carried thither by pilgrims from Syria; therefore, so much for the opinions of men of science of the last century." Although we can by no means recognise Voltaire as a true man of science, and though we consider his explanations of fossil shells as utterly groundless, we must remember that the former of them was shared by many orthodox divines, and that neither of them is more outrageous than their ascription to the Noachian deluge, or than the hypothesis advanced by a man of science still living that they are forgeries, divinely perpetrated to lead vain man into error. If Mr. Hughes will search he will find that the eighteenth century is rich in illustrious men of science.

We are by no means disposed to deal severely with inelegancies and inaccuracies of expression so long as they do not obscure an author's meaning. Still, such utterances as "I have added an addenda," "an isolated strata," &c., rather grate upon our feelings. What, too, must the classical scholar think of the subjoined rendering:—"eocene, miocene, pliocene and, post-pliocene, all compounded of Greek words signifying 'earliest new,' 'less new,' 'more new,' and 'often more new.'"

We very much regret that in the interests of science we cannot give this book our recommendation.

Annual Record of Science and Industry for 1878. Edited by SPENCER F. BAIRD, with the assistance of eminent men of Science. New York: Harper Brothers. London: Trübner and Co. 1879.

THE eighth issue of this useful compilation is fully equal to those which have preceded it. The volume is divided into sixteen sections—Astronomy, Physics of the Globe, Physics in General, Chemistry, Mineralogy, Geology, Hydrography, Geography, Microscopy, Anthropology, Zoology, Botany, Agriculture, Engineering, Technology, and Industrial Statistics. The Appendix contains a necrology and the bibliography of the year.

One of the best sections in the book is the first, Astronomy, edited by Prof. E. S. Holden, of the Naval Observatory, Washington. The great solar eclipse of July 29th, 1878, of course occupies the largest amount of space, the American observers naturally getting the lion's share. The transits of Mercury and Venus, also, come in for a large share of attention. Professor Holden gives an interesting *bibliographie raisonnée* of his own particular subject, and it would have been as well if all his colleagues had followed his example instead of relegating the matter to an Appendix. So much trash in a scientific way is published now-a-days that one wants to know briefly, but honestly, what a book is worth, and not merely its name, author, size, and price. An interesting Report on American Observatories is given in this section.

The section edited by M. Clement Abbé and Prof. Rockwood, and devoted to Physics of the Globe, is also well treated, taking up no less than 118 pages, or a fifth of the whole book. The subject is well arranged, being divided into three broad headings —the Earth, the Ocean, and the Atmosphere. The value of the section is however, greatly impaired by the paucity of bibliographical references. Such books as the present are not bought merely as a matter of scientific curiosity, but as works of reference, and neither names, discoveries, nor researches should be mentioned without giving every particular that is necessary for obtaining a perfect knowledge of the matter.

These remarks apply with more or less justice to many of the other sections, especially to that on Physics, by Professor Barker, which is the most deficient of them all in bibliographical references.

The very unequal amount of space given to the different sections is apparent in the meagre account given of the year's chemical research, also by Prof. Barker.

Setting aside the defects we have mentioned, Mr. Baird's work is most valuable.

CORRESPONDENCE.

THE ANOMALOUS SEASON.

To the Editor of the Monthly Journal of Science.

SIR,—The author of the article "The Anomalous Season," inserted in your last issue, might have added, on the authority of Knapp, that the hot summer of 1825 had been preceded by a mild wet winter, and was followed by another summer almost as hot and dry, whilst in the intervening winter (1825-26) snow and frost only lasted about ten days. This certainly confirms the view that exceptional weather, when it sets in, lasts for more than one season, and that a warm summer is generally preceded by a mild winter.—I am, &c.,

AN OBSERVER.

ACTION OF LIGHT UPON THE COLOURATION OF THE ORGANIC WORLD.

To the Editor of the Monthly Journal of Science.

SIR,—I have this year observed a phenomenon which scarcely agrees with certain generalisations upon which I ventured in an article on "The Action of Light upon the Colouration of the Organic World." I there said that "pure and bright colours are connected with the highest vitality only," and further, that the process of decay is "attended by a degradation of colour." This year, however, I have been struck with the fact that the flowers of the common whitethorn, when about to fall and after their odour has disappeared, assume, not like other white flowers a dirty brown, but a pure and delicate pink or rose shade, with minute specks and points of a very decided red. I have carefully examined these colours, and find them free from any approach to a maroon or a liver.colour, which we might more easily associate with decay. It is striking that we should have here a change exactly the reverse of what takes place in the rose, the apple-blossom, and the almond. All these open with various shades of red or pink, and fade towards a white; yet they belong to the same botanical family as the whitethorn. The change in question, though very general, was by no means universal, and it seemed to me most pronounced in situations little exposed to the direct rays of the sun.—I am, &c.,

J. W. S.

HUMANITARIANISM EXTRAORDINARY.

To the Editor of the Monthly Journal of Science.

Sir,—At a meeting held in connection with the recent Westminster Exhibition, Mr. J. G. Talbot, M.P., is reported to have said, in reference to some cases of butterflies there displayed, that such collections involved a "fearful waste of insect life," and to have expressed a wish that Entomology could be "studied in a more humane manner." It really seems as if, in these virtuous days, the infliction of pain or of death is to be tolerated for any and every purpose, save in the pursuit of knowledge. The number of insects sacrificed for preservation in museums and in private collections, or for microscopic examination, &c., seems to me a mere trifle compared with those destroyed out of mere wantonness or for ostentatious decorations. In the shops of certain "naturalists" (save the mark!) we may see trays and boxes full of splendid Buprestidæ, &c., which are sold to jewellers, milliners, &c. Might not Mr. Talbot have found here a "waste of insect life" much more to be regretted? With birds the case is even more glaring. I will venture to say that for one which falls a sacrifice to Science, ten become victims to Sport and to Fashion. But the modern humanitarian dares not attack Sport and Fashion, so he seeks to fetter Science. Biologists greatly deceive themselves if they think that even the total abolition of vivisection will satisfy the "hysterical party." It is surely time for the organisation of a "Biological Defence League."—I am, &c.,

Awake!

HABITS OF SERPENTS.

To the Editor of the Monthly Journal of Science.

Sir,—Waterton strongly insists, in his Essays, that serpents never pursue a retreating prey, and never act gratuitously upon the offensive. Both these statements are contradicted by more recent observers. The late Mr. Belt describes a serpent chasing a lizard among the branches of a tree, and Dr. Livingstone gives an instance of an African serpent emerging from its hole, biting with fatal effect a man who was passing, and then returning to its hiding-place. Is anyone among your readers able to state whether wild animals, too large to become the prey of poisonous snakes, are ever bitten and destroyed by them? Has anyone ever found in the woods of India, of the Malayan Islands, or of Africa, any dead carnivore, ape, antelope, &c., whose death could be plainly traced to serpent-bite? That domestic animals thus perish, especially dogs, is a well-known fact.—I am, &c.,

VERIFIER.